ARLINGTON FINANCE COMMITTEE
MINUTES OF MEETING
03/8/2023 7:30 PM
Via Remote Participation - Zoom

ATTENDEES

Remy	P	White	P	Griffin	P	Bliss	P
Blundell	P	Younkin	P	Harmer	P	Tosti	P
Susse	P	Lobel	A	LaCourt	P	Deshler	P
Migliazzo	P	Gibian	P	Jones	P	Carman	P
Beck	A	Foskett	P	Heigham	P	McKenna	P
						Bradley	P

P indicates Present; L indicates late; A indicates Absent

Visitors: Jose Farias (Capital Planning Committee, School Accountant), Timur Yontar (Capital Planning Committee, Chair), Joseph Barr (Capital Planning Committee, Secretary), Alex Magee (Deputiy Town Manager – Finance Director), Jonathan Haughton (Capital Planning Committee), Ida Cody (Town Comptroller), Kate Loosian (Capital Planning Committee), Joe Solomon (Capital Planning Committee), Sean Keane (ACMI)

BUDGETS, ARTICLES & ITEMS

1. Capital Planning Committee
   a. Non-exempt capital spend is budgeted at 5% of adjusted Town revenue (5% rule)
   b. Current year "Capital Budget" will be in balance (overall "Five-Year Plan" will be in balance with potential variation in years 2-5)
   c. Operating expenses continue to move to Operating Budget as there is room to accommodate
   d. FY24 Capital: $11.1 M for Capital (before offsets); $9.5 M net (after offsets)
   e. Fox Library is likely the next large (building-sized) capital project
   f. Ottoson school projects have been focused on urgent repairs
   g. $13,385,126 total cost of capital items to buy for Town in FY24
   h. VOTE: the Capital Planning budget appropriating $19,183,900 in Total Debt Service, $18,446,911 in Net General Fund Debt (Total Debt Service less $736,989 in Total Other Financing Sources) for a Total Net Capital Appropriation of $22,380,767 was approved unanimously
   i. VOTE: Recission of $300,000 in prior borrowing was approved unanimously
2. Summary

Budget Name	Amount	Status
Capital Planning	22,380,767	Approved
WA 40 – Rescind Borrowing	300,000	Approved

MINUTES

1. Meeting minutes from 3/6/2023 were approved with 15 in favor and two abstaining (Migliazzo, Carman)

CONCLUSION

The meeting adjourned at 10:07 pm.
The next meeting is Monday, March 13, 2023

Tara Bradley
3/9/2023

Reference 1: FY24 CPC FinCom Presentation
Reference 2: FY24-FY28 Capital Plan Detail
Reference 3: FY24-FY28 New Debt Service
Reference 4: FY24 Capital Budget
Reference 5: CPC Presentation Q&A
Reference 6: Appendix A – Scoping Study Narrative
Reference 7: Arlington Pavement Management System Update
Reference 8: Sidewalk, Ramp, Curb and Street Tree Evaluation
Reference 9: FY24 CPA Application, Town Hall Envelope Restoration Phase 1 Clock Tower
Reference 10: Electrification & Air Quality Master Plan Final Report

Reference 1

Capital Planning Committee

Capital Budget FY2024 and Capital Plan FY2024–FY2028

A Presentation to the Arlington Finance Committee

February 27, 2023

DPW Renovation as of February 2023

Agenda

- Actions Requested
- Who We Are
- What We Do
- What Capital Is
- Overview & Significant Issues
- Capital Plan Progress
- Town Budget; Five-Year Plan within 5% Rule
- Detail on Current Recommendations
  - Sources: Cash, Bond, Other; ARPA federal funds
  - Uses: Public Works, Schools, Community Safety (Fire & Police), Recreation, Libraries, Other Notable Items
- Rescission of Prior Borrowing; Re-appropriations
- Actions Requested (recap) and Recommended Vote

Actions Requested of the Finance Committee

- Vote favorable action on:
  - our recommended budget
  - re-appropriation
  - bond authorization rescission
- Endorse the Five-Year Plan

Who We Are
Membership

Citizen Appointees

- Timur Kaya Yontar – Chair
- Christopher Moore – Vice Chair
- Joseph Barr – Recording Secretary
- Jonathan Haughton
- Kate Loosian
- Joseph Solomon

Finance Committee Designee

- Darrel Harmer

Town Officials

- Ida Cody – Comptroller
- Phyllis Marshall* – Treasurer
- Jose Farias – APS School Accountant
- Julie Wayman – Budget Director

*Retires at end of Feb 2023

Who We Are
Committee Organization 2022–2023

Capital Planning Committee

- **Public Works and Recreation**
  - Joe Barr
  - Phyllis Marshall
  - Joe Solomon
    - Highway
    - Engineering
    - W+S Enterprise
    - Cemetery
    - Natural Resources
    - Burns Rink Enterprise
    - Parks and Playgrounds
- **Administration**
  - Ida Cody
  - Jonathan Haughton
  - Kate Loosian
    - Town Manager
    - Education
    - Select Board
    - Library
    - Legal
    - Facilities
    - Purchasing
    - Clerk's Office
    - Information Technology
- **Finance**
  - Darrel Harmer
  - Chris Moore
    - Treasurer
    - Comptroller
    - COA Enterprise Funds
    - Human Services
    - Planning and Community Development
- **Community Safety**
  - Jose Farias
  - Timur Yontar
    - Police
    - Fire
    - Inspectional Services

What We Do
Why Capital Planning?

- To set and meet the long-range expectations
  …of Town officers and management, the Finance Committee, Town Meeting, and citizens
  …for current and future capital expenditures;

- To reduce or eliminate uncertainty about the acquisition of capital assets;

- To facilitate prioritization, in timing and/or spend, of some capital expenditures over others as part of the budgeting process; and

- To give Town Meeting and citizens confidence while spending large sums of taxpayer money.

What We Do
Arlington Capital Planning Practice

Create a Five-Year Plan in which non-exempt capital spend is budgeted at 5% of adjusted Town revenue, by:

- Soliciting capital requests from Town Departments for the upcoming fiscal year and the four fiscal years following;
- Meeting with Departments and Facilities to gain further clarity and detail, then discussing and prioritizing in the full committee; and
- Forecasting future years' budgets to effectively plan and pace capital expenditures.

- Since 1987, long history of successful capital planning within budget.
- 5% Rule has met the Town's needs, guided fiscal discipline, and is in line with practice at other municipalities.
- Requests from Town and Schools are made with their knowledge of operating pressures.

What Capital Is

Capital Asset

1. Has an expected useful life of at least two years and
2. Either has a unit cost of at least $3,000 or is purchased in a program to gradually purchase a quantity of essentially identical units such that the total price is over $25,000

Capital Improvement

1. Adapt a capital asset to a different use or
2. Appreciably lengthen the useful life of the capital asset beyond what may be expected with normal maintenance

What Capital Is (cont'd)

Examples

- New electric wiring, a new roof, a new floor, new plumbing, bricking up windows to strengthen a wall, and lighting improvements.
- Conversely, interior painting is not considered to be a Capital Improvement unless the painting is part of a larger project that would be classified as a Capital Improvement if there were no painting.

Expenditures are in the Capital Plan only when they are

1. For a Capital Improvement, or
2. For the purchase or lease of a Capital Asset, or
3. For plans or studies in preparation for the purchase of a Capital Improvement or the purchase or lease of a Capital Asset.

Capital Budget and Five-year Plan

- FY24 Capital Budget: a plan for actual capital spending in the upcoming fiscal year.
- Five-Year Capital Plan: covers the five years FY24–FY28 and shows *anticipated* capital projects and funding sources.
  - We expect it to change over time.
  - We limit the net Capital Plan to 5% of the Town Budget summed over the five years of the plan.
  - Gives context and visibility into future expenditures.
- Town Meeting only votes to approve the FY24 Capital Budget.

Changes to Planning Practice this Year

- In the past, the Committee has made small changes to project timing and funding sources in order to produce a five-year plan with every one of the five years in balance.

- Going forward, the current year *Capital Budget* will be in balance and the overall *Five-year Plan* will be in balance but there may be variation in years 2–5.
  - This will provide useful feedback to the Town by making it clear which future years are likely to have tight Capital Budgets.

- Historically, certain expenses that are arguably operating expenses have been tolerated in the Capital Budget.
  - We have continued to move these to the Operating Budget as there is room to accommodate them.

Overview & Significant Issues

FY24 Budget and FY24–FY28 Plan are at 5% of Town Budget

- FY24: $11.1 M for Capital (before offsets); $9.5 M net (after offsets)
- This year the plan felt tight due to:
  - Cost estimates escalating
    - Due to general inflation in materials & labor and supply-chain issues & delays
  - Long-term cost uncertainty
  - Continued movement toward more proactive maintenance of aging facilities
  - Ongoing desire to improve services and strive for excellence
  - Increased borrowing costs
- "ARPA" federal funds still available for HVAC & recreation capital costs
  - One-time funding source

Overview & Significant Issues (cont'd)

Multiple approaches to bring Plan into balance…

- APS withdrew most capital requests for Ottoson
  - De-prioritized long-term investments in anticipation of future rebuild
- Operating expenses moved off Capital Plan
  - Examples: Bulletproof vests; firearms; cloud IT services
- CPC members created ranked list of all line items
  - Coordinated delays/cuts with Town Manager's office
- Main scope reductions
  - DPW: Roadways level-funded
  - EV Charging Stations (will apply for grant funding)
  - Whittemore Robbins estate renovation scope
- Future concerns include: APS facilities maintenance; when the Plan will have capacity for next large (building-sized) project for Libraries

Capital Plan Progress

Recent realized benefits from Capital Plan Projects

- Town Hall envelope study
- Engineering Study for electrification of schools
- Hardy + Peirce Playgrounds
- Voting Machines
- Ottoson urgent repairs
- Vehicle replacement programs (slowed by COVID)
- Rink: Bleacher lift, boiler repair, roof work
- School and Town IT Projects

Capital Projects in process:

- Water & Sewer Improvements
- Roadways & Sidewalks
- Community Center
- DPW building
- Mystic Street Bridge
- High School (exempt)

Capital Projects in Planning:

- Whittemore Robbins Complex
- Town Hall
- Veterans Memorial

Reference 1

Reconciliation to Town Budget
Five Year Plan

Year	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
Total Town Budget	$ 205,160,270	$ 213,694,204	$ 221,615,100	$ 230,282,759	$ 238,955,229
Adjust for Water Sewer	$0	$0	$0	$0	$0
Adjust for Exempt Debt Service	($12,028,956)	($11,917,651)	($11,824,004)	($11,586,563)	($11,494,904)
Adjust for Enterprise Funds	($3,262,492)	($3,368,523)	($3,478,000)	($3,591,035)	($3,707,744)
Adjusted Total Town Budget	$189,868,822	$ 198,408,030	$206,313,096	$215,105,161	$223,752,581

- As of 1/15/23. Five-Year Plan is a dynamic document.

Reference 1

Five-Year Plan within 5% Rule

Fiscal Year	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	Total
Prior Non-Exempt Debt Service	$7,036,880	$6,623,138	$6,354,779	$5,918,157	$5,707,966	$31,640,920
Cash	$3,933,856	$4,264,027	$4,032,788	$4,197,830	$4,319,958	$20,748,459
New Non-Exempt Debt Service (FY24 & after)	$0	$689,698	$1,121,387	$1,619,205	$1,927,024	$5,357,314
BAN Interest	$118,064	$0	$0	$0	$0	$118,064
Total Non-Exempt Plan Cost	$11,088,800	$11,576,863	$11,508,954	$11,735,192	$11,954,948	$57,864,757
Direct funding sources:						
Antenna Funds	($93,252)	($167,042)	($168,877)	($148,499)	($147,499)	($725,169)
Capital Carry Forwards	($546,703)					($546,703)
Bond Premium, prior five years	($25,778)					
Recreation Enterprise Fund	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($75,000)
Rink Enterprise Funds	($56,256)	($56,256)	($31,097)	($30,269)	($30,269)	($204,147)
Adjustments to 5% Plan:						
Roadway Reconstruction Override 2011	($524,834)	($537,955)	($551,404)	($565,190)	($579,320)	($2,758,703)
Accessibility Improvements Override 2019	($215,378)	($220,763)	($226,283)	($231,941)	($237,740)	($1,132,105)
Debt service, Town-owned Rental Properties	($9,299)	($8,500)	($8,250)	($8,000)	($7,750)	($41,799)
Debt service, Ambulance Revenue	($67,500)	($145,750)	($139,625)	($75,000)	($71,875)	($499,750)
Community Center Rent	($42,544)	($40,944)	($34,494)	($33,467)	($33,467)	($184,915)
Net Non-Exempt Plan	$9,492,256	$10,384,653	$10,333,924	$10,627,826	$10,832,028	$51,670,688
Pro Forma Budget	$189,868,822	$198,408,030	$206,313,096	$215,105,161	$223,752,581	$1,033,447,690
Budget For Plan at 5%	$9,493,441	$9,920,402	$10,315,655	$10,755,258	$11,187,629	$51,672,385
Plan as % of Revenues	5.00%	5.23%	5.01%	4.94%	4.84%	5.00%
Variance From Budget	$1,185	($464,252)	($18,269)	$127,432	$355,601	$1,697

Capital Funding Sources

In the Capital Planning process, we track three different sources of funding for projects. Each has a different impact on current and future expenditures.

- Cash: Paid for in their entirety in a certain year from the general fund.
- Bond: Paid for with money borrowed from the municipal bond market. No cost in the year of purchase. Repayment *with interest* is made over the "useful life" of the capital asset.
  - Generally, we bond items >$100 K which are not part of regular purchase programs (i.e. not items that we purchase every year or every other year).
- Other: Paid for by outside sources not arising from the Town's tax levy. Includes state & federal grants (e.g., Ch. 90, ARPA), user fees, private donations, trust funds, enterprise funds, etc.

Sources: ARPA-Funded Projects
Nearly $1.7 M "Other" for FY24 Capital Budget

One-time federal fund windfall: address maintenance & upgrade backlog and benefit Town in wake of COVID pandemic impact

- HVAC
  - $940 K for Schools HVAC (Bishop, Dallin, Hardy, Thompson)
  - $750 K for Town HVAC (Community Center, Police Station, Park Circle Fire Station, Cottage at Whittemore Robbins)

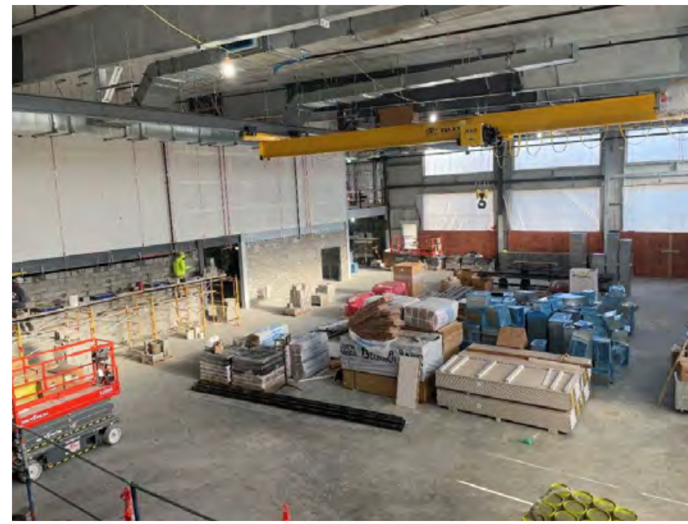
Uses: High-Level Summary
Proposed FY24 Acquisition Expense

- $13,385,126 total cost of capital items proposed to buy for the Town in FY24, by Department and Funding Source (table amounts $ K)

Department	Bond	Cash	Other	TOTAL	%
Public Works*	$380	$1,748	$3,935	$6,063	45%
Schools (incl School IT)	$1,700	$1,021	$1,015	$3,736	28%
Community Safety	$375	$240	$447	$1,062	8%
Health & Human Svcs.	$720			$720	5%
Planning	$166	$205	$225	$596	4%
Libraries	$146	$131	$22	$299	2%
IT (excl School IT)		$217	$70	$287	2%
Other**	$200	$372	$50	$622	5%
TOTAL	$3,687	$3,934	$5,764	$13,385	100%

*Public Works includes $2.975 M for Water & Sewer funded by the Water & Sewer enterprise fund ("Other").
**Comprises Facilities, Recreation, Purchasing, Town Manager, Clerk

Project Update
DPW: Public Works Facility



- Total project allocation is on budget at $46.52 M
- Construction is progressing with finishing work underway on the new building and additional sitework underway
- Phase 1 (new building) is on track for a Spring 2023 completion with the remaining work on track for Fall 2023 completion

Detail of Current Recommendations
DPW: Roadway and Sidewalk Maintenance

Roadways

Average Capital Funds of $1.72 M/year

From 2019 Pavement Management Report:
- Pavement Condition Index (PCI) reported as 79 with target score of 80
- Total backlog* of work = $24.4 M
- Funding of $1.5 M/year would maintain the score at 78
- Funding of $2.0 M/year would maintain the score at 80

Sidewalks, Curbs, and Ramps

Average Capital Funds of $0.94 M/year

From 2015 Sidewalk, Ramp, Curb and Street Tree Evaluation:
- Sidewalk Condition Index (SCI) reported as 76.7
- Total backlog** of work = $26.1 M
- No "target" for score/funding but all funds committed are used against existing backlog.

*Backlog is defined as amount to get all roads to "Excellent" condition. **Backlog is defined as restoring sidewalks with Poor condition, 50% of sidewalks with Fair condition, sidewalks impacted by trees, missing sidewalks, poor condition and missing curbs, non-compliant & missing ramps

Detail of Current Recommendations
DPW: Overall

DPW Division	FY24		FY25–FY28	
	General	Vehicles	General	Vehicles
Administration	-	-	$2,400,000	-
Cemetery	-	$75,000	$40,000	-
Engineering	-	-	$50,000	-
Highway	$2,537,211	$398,000	$11,000,584	$1,295,000
Natural Resources	-	$78,000	-	$858,500
Motor Equip Repair	-	-	-	-
Water/Sewer	$2,975,000	-	$12,465,000	$606,000
Total	$5,512,211	$551,000	$25,955,584	$2,759,500

FY24 total ex Water/Sewer: $3.09 M   Overall Total (FY24–FY28): $34.78 M

Project Update
Arlington High School

PHASE	CONSTRUCTION	DATE
1	STEAM* & Performing Arts wings	Completed 2022
2	Humanities, Central Spine, Cafeteria, Library, Preschool, District Offices	Scheduled to open 9/2023
3	Athletics wing	9/2023-8/2024
4	Fields and site work	8/2024-8/2025

* STEAM=Science, Technology, Engineering, Arts & Math

AHS Phase 2 Construction

AHS Phase 1 Complete – STEAM & Performing Arts Wing

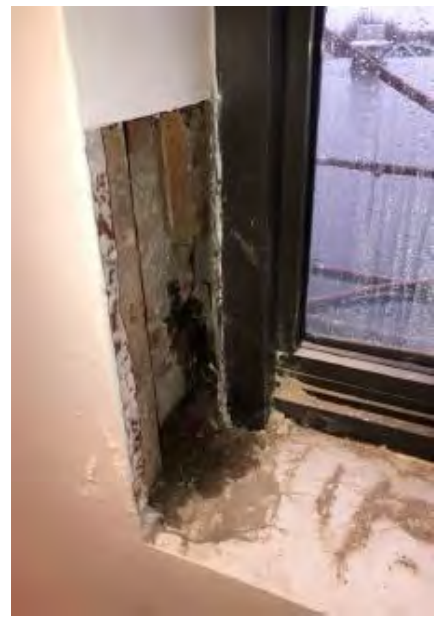
Detail of Current Recommendations
APS Major Renovations

<u>Bishop School: $2.45 M (FY24–FY25)</u>

- Roof replacement: $1.6 M FY24
- RTUs, EMS upgrades: $150 K FY24 (ARPA)
- Envelope repairs: $500 K FY25
- Front Office Reconfiguration: $200 K FY25

<u>Hardy School: $3.15 M (FY23–FY26)</u>

- Roof replacement: $400 K FY23 (Work In Progress)
- RTUs, EMS upgrades, boilers: $450 K FY24 (ARPA)
- Envelope repairs: $2.2 M FY26



Note: Throughout the deck, FY24 Capital Budget items' dollar amounts are shown in black text, and FY25–FY28 Capital Plan items' dollar amounts (in the "out-years") are shown in grey text

Project Update
School Playgrounds

Brackett Playgrounds – $880 K

- $ 80 K FY23 (survey work complete)
- $ 800 K FY25

Detail of Current Recommendations
Community Safety – Fire

<u>Non-Facilities-Related Requests</u>

Rescue Ambulance Replacement Program

- $375 K FY24, $400 K FY27

Firefighter protective gear: $30 K FY24

- Remains at $30 K/year in FY25

LUCAS 3 Chest Compression System: $20 K FY24

Vehicle Replacement Program FY25–FY28

- $1.44 M comprising 7 vehicles including a pumper

Jaws of Life Extrication Equipment: $50 K FY26

Exercise Equipment FY28: $50 K FY28

Detail of Current Recommendations
Community Safety – Fire (cont'd)

<u>Facilities-Related Requests</u>

Park Circle:

- Mechanical System Replacement: $175 K FY24

Highland Station:

- Mechanical System Replacement: $446 K FY26

Central Station HQ:

- Exterior Waterproofing: $50 K FY26
- Mechanical System Replacement: $201 K FY27

Detail of Current Recommendations
Community Safety – Police

Ongoing vehicle replacement program

- $160 K/year, replacing 2 marked cars + 1 unmarked car or motorcycle each year

Cooling Tower repl.: $250 K in FY24 (Other: ARPA)

- Not replaced in Police Station renovation; insufficient to cool building; replacement will have increased capacity

"QED" Server: $15 K in FY24

- APD's report writing & tracking system; end of useful life

Bola Wrap De-escalation Tools: $15 K in FY24

- "Non-force" option to restrain offender at a distance

Shifted to operating budget: Bullet-proof vest program, $22 K/year
Out-years: Parking control vehicle $32 K in FY25; Specialty vehicle replacement. $50 K in FY27

Detail of Current Recommendations
Recreation – General

Total FY24 Requests from Capital: $205 K

Yearly/Ongoing Programs

- Playground Audit and Safety Improvements Program
  - $70 K in FY24, $75 K/year on an ongoing basis
- ADA Study Implementation Program
  - Improve the accessibility of the Town's parking and playgrounds
  - $50 K/year on an ongoing basis
- Feasibility Study Program
  - Study future upgrades of park and playground facilities
  - $10 K/year on an ongoing basis

Ed Burns Arena Parking Study: $75 K

Recent Progress and Future Needs
Recreation — Playgrounds

The three ARPA-funded playground renovations at Bishop, Peirce, and Stratton schools have all opened as of late 2022, with some remaining punch list items (https://www.arlingtonma.gov/i-want-to/learn-about/arpa-programs)

Without ARPA funding available, future planned playground renovations will need to be funded from the Capital Plan or the Community Preservation Act.

Current programmed funding:

- Parallel Park: $500 K (FY25)
- Thorndike Field Initial Design: $250 K (FY26)
- Waldo Park: $600 K (FY27)

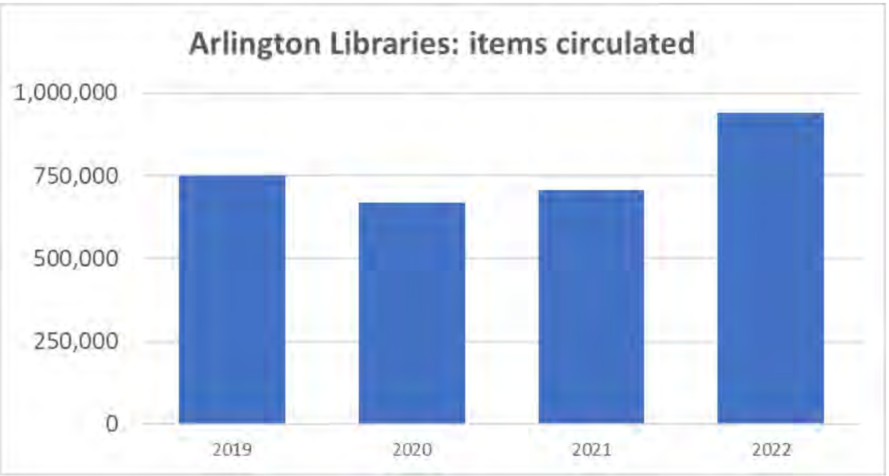
Detail of Current Recommendations
Robbins Library Renovations

Lighting Project – Greener and Brighter Library

Existing condition:
- Insufficient lighting, out-of-date and high energy-use lighting
- Many areas are too dim (hall, stairways); some rooms go completely dark

Scope
- Strip lighting will be retrofitted with new LED lamps and driver

Cost and Savings
- $146,270 – Town share
- $ 9,473 – Eversource rebate
- Estimated ~$30 K annual savings
- Payback period ~5 years



Following a dip during the COVID pandemic, Arlington libraries' circulation has rebounded

Other Notable Items in FY24

- Veterans' Memorial Park
  - $200 K design and planning
  - $2.65 M construction cost (out-years)
  - 61% of total to be paid by grants, earmarks, and donations
- Whittemore Robbins Estate Rehab: $520 K
- Community center elevator: $166 K
- Townwide ADA accessibility upgrades: $100 K
- Academic PCs for schools: $400 K

Reference 1

Rescission of Prior Borrowing

Warrant Article: Rescind Borrowing Authorizations form Prior Years

"To see if the Town will vote to rescind the authority to borrow, from prior years' authorizations, the amounts remaining with regard to any numbered prior Annual and/or Special Town Meeting Warrant Articles"

- VOTED: To Rescind Authority to Borrow totaling $300,000 as recommended by the Treasurer of previously authorized un-issued debt, comprised of amounts voted by the Town under the following warrant articles:

Amount Rescinded	Warrant Article	Town Meeting Purpose
$300,000	Article 30, 2014 TM	Water Meter Installation

COMMENT: These recissions are from previously authorized borrowings for projects which have been completed and which amounts are unissued debt that is no longer required

Re-appropriation of Borrowed Funds (1 of 2)

Motion: That the sum of $203,815.91 is hereby transferred from amounts previously appropriated and borrowed under the following warrant articles and for the purposes set forth as follows:

Amount to be transferred	Warrant Article	Meeting Date	From Original Purpose
$ 10,794.51	5	4/27/2016	AHS Feasibility Study
$ 10,799.87	58	5/8/2019	Portable Radios – Fire
$ 13,488.33	30	4/25/2018	Dallin – Chiller
$ 141,225.55	54	6/15/2020	Hardy Playground
$ 20,000.00	54	6/15/2020	Ottoson HVAC
$ 7,507.65	54	6/15/2020	Pierce Playground
$ 203,815.91			Total

Re-appropriation of Borrowed Funds (2 of 2)

...which amounts are no longer needed to complete the projects for which they were initially borrowed, to pay costs of the following as permitted by MGL Ch. 44, §20:

Amount to be Paid	For New Purpose
$ 75,000.00	Town Hall Renovations
$ 100,000.00	ADA Accessibility construction – Planning
$ 28,815.91	Sidewalk Ramp Installation
$ 203,815.91	Total

Actions Requested of the Finance Committee

- Vote favorable action on:
  - our recommended budget
  - re-appropriation
  - bond authorization rescission
- Endorse the Five-Year Plan

Recommended Vote

We ask you to vote the capital expenditure budget as follows:

General Fund Debt Service				
Non Exempt, Prior	$	7,036,880		
Non Exempt, New	$	118,064		
Total Non-Exempt Debt			$	7,154,944
Exempt Debt			$	12,028,956
Total Debt Service Appropriation			**$**	**19,183,900**
Less				
Antenna Fund	*$*	*(93,252)*		
Capital Carryforwards	*$*	*(546,703)*		
Bond Premium, prior fiscal years	*$*	*(25,778)*		
Recreation Enterprise Funds	*$*	*(15,000)*		
Rink Enterprise Funds	*$*	*(56,256)*		
Total Other Financing Sources			***$***	***(736,989)***
Net Non-Exempt Debt			$	6,417,955
Exempt Debt			$	12,028,956
NET General Fund Debt			**$**	**18,446,911**
Cash Capital			$	3,933,856
TOTAL NET Capital Appropriation			**$**	**22,380,767**

- If we make any subsequent modifications, Fin Comm will have opportunity to review them.

Attachments

- FY 2024 Capital Budget
- FY 2024–FY 2028 Capital Plan
- Forecast of New Debt Service

In Conclusion

We respectfully ask for
your endorsement of
the Capital Planning Committee's
budget recommendation.

Thank you!

TOWN OF ARLINGTON

CAPITAL PLAN FY2024-FY2028

Reference 2

CAPITAL PLAN DETAIL FY2024-FY2028

	FUNDING SOURCE	LIFE (YRS)	2024	2025	2026	2027	2028	TOTAL
CLERK'S OFFICE			**$ 26,791**	**$ 7,980**	**$ 2,521**	**$ -**	**$ 11,365**	**$ 48,657**
Election Poll Pads	OTHER				$ 2,521		$ 11,365	$ 13,886
New Voting Booths	CASH		$ 26,791	$ 7,980	$ -	$ -	$ -	$ 34,771
COMMUNITY SAFETY - FIRE SERVICES			**$ 600,000**	**$ 147,000**	**$ 576,250**	**$ 698,250**	**$ 1,348,400**	**$ 3,369,900**
Central station exterior waterproofing	CASH	10		$ -	$ 50,000			$ 50,000
Exercise Equipment - 3 Stations	CASH						$ 49,000	$ 49,000
Firefighter Protective Gear	CASH		$ 30,000	$ 30,000	$ 30,000	$ 35,000	$ 35,000	$ 160,000
Headquarters - Mechanical System Replacement	BOND	15				$ 201,250		$ 201,250
Highland - Mechanical System Replacement	BOND	10			$ 446,250			$ 446,250
Jaws of Life - Extrication Equipment	CASH		$ -		$ 50,000			$ 50,000
LUCAS 3 - Chest Compression System	CASH	7	$ 20,000					$ 20,000
Park Circle - Mechanical System Replacement	OTHER	10	$ 175,000					$ 175,000
Rescue Ambulance replacing #1026	BOND	6	$ 375,000					$ 375,000
Rescue Ambulance replacing #1032	BOND	6				$ 400,000		$ 400,000
Vehicle Replacement - #1005 2008 Seagrave Pumper	BOND	10					$ 1,050,000	$ 1,050,000
Vehicle Replacement - #1018 2012 F250 M2	CASH	13		$ 60,000				$ 60,000
Vehicle Replacement - #1022 2014 Ford Interceptor	CASH			$ 57,000				$ 57,000
Vehicle Replacement - #1023 2014 Ford Explorer	CASH					$ 62,000		$ 62,000
Vehicle Replacement - #1024 2016 Ford Fusion Hybrid	CASH						$ 73,700	$ 73,700
Vehicle Replacement - #1027 2018 Ford Explorer	CASH						$ 73,700	$ 73,700
Vehicle Replacement - #1028 2017 Ford Interceptor	CASH						$ 67,000	$ 67,000
COMMUNITY SAFETY - POLICE SERVICES			**$ 462,133**	**$ 217,000**	**$ 200,000**	**$ 250,000**	**$ 225,000**	**$ 1,354,133**
Bola Wrap De-Escalation Tools	CASH		$ 15,000					$ 15,000
Bullet Proof Vest Program	OTHER		$ 22,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 122,000
Cooling Tower	OTHER	15	$ 250,000					$ 250,000
Parking Control Vehicle(s)	OTHER			$ 32,000				$ 32,000
QED Server	CASH		$ 15,133					$ 15,133
Specialty Vehicle	CASH			$ -		$ 50,000		$ 50,000
Vehicle Replacement Program	CASH		$ 160,000	$ 160,000	$ 175,000	$ 175,000	$ 200,000	$ 870,000

Reference 2

CAPITAL PLAN DETAIL FY2024-FY2028

	FUNDING SOURCE	LIFE (YRS)	2024	2025	2026	2027	2028	TOTAL
FACILITIES			**$ 275,000**	**$ 75,000**	**$ 75,000**	**$ 75,000**	**$ 75,000**	**$ 575,000**
Central School building envelope repairs	BOND	20	$ 200,000					$ 200,000
Town Hall - Renovations	CASH		$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 375,000
HEALTH & HUMAN SERVICES			**$ 720,000**	**$ 927,677**	**$ 1,757,500**	**$ 40,000**		**$ 3,445,177**
Council on Aging Van replacement	OTHER		$ -	$ 40,000	$ -	$ 40,000		$ 80,000
Veterans Memorial Park	BOND	20	$ 200,000	$ 87,677	$ 807,500			$ 1,095,177
Veterans Memorial Park	OTHER			$ 800,000	$ 950,000			$ 1,750,000
Whittemore Robbins Estate Rehab	BOND	20	$ 520,000					$ 520,000
INFORMATION TECHNOLOGY			**$ 867,000**	**$ 1,060,000**	**$ 905,000**	**$ 875,000**	**$ 855,000**	**$ 4,562,000**
Application Modernization Initiative	OTHER		$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 200,000
Conference Room Presentation Technology Program	CASH			$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 40,000
Conference Room Presentation Technology Program	OTHER		$ 30,000					$ 30,000
District Audio Visual Support	CASH			$ 200,000	$ 50,000	$ 20,000	$ 20,000	$ 290,000
School - Admin Computers and Peripherals	CASH		$ 60,000	$ 60,000	$ 65,000	$ 65,000	$ 65,000	$ 315,000
School - Network Infrastructure	CASH		$ 80,000	$ 50,000	$ 50,000	$ 50,000	$ 30,000	$ 260,000
School - Replacement academic PC's district wide	CASH		$ 400,000	$ 520,000	$ 500,000	$ 500,000	$ 500,000	$ 2,420,000
School - Software Licensing	CASH		$ 40,000	$ 50,000	$ 55,000	$ 55,000	$ 55,000	$ 255,000
Town Microcomputer Program	CASH		$ 62,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 322,000
Town Software Upgrades & Standardization	CASH		$ 155,000	$ 65,000	$ 70,000	$ 70,000	$ 70,000	$ 430,000
LIBRARY			**$ 299,073**	**$ 72,030**	**$ 69,903**	**$ 70,703**	**$ 55,703**	**$ 567,412**
Energy Management System	CASH		$ 77,000					$ 77,000
MLN Equipment Schedule	CASH		$ 53,803	$ 50,030	$ 47,903	$ 48,703	$ 33,703	$ 234,142
MLN Equipment Schedule	OTHER		$ 22,000	$ 22,000	$ 22,000	$ 22,000	$ 22,000	$ 110,000
Robbins Library Lighting Project	BOND	10	$ 146,270					$ 146,270
PLANNING			**$ 596,000**	**$ 155,000**	**$ 155,000**	**$ 205,000**	**$ 155,000**	**$ 1,266,000**
BLUEBikes Expansion	CASH		$ -			$ 50,000		$ 50,000
Community Center Air Handler Replacement	OTHER	10	$ 225,000					$ 225,000
Community Center Elevator Replacement	BOND	15	$ 166,000					$ 166,000
Design and engineering consultants	CASH		$ 75,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 175,000
Electrification and air quality master planning	CASH		$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 150,000
Townwide ADA acccessibility upgrades	CASH		$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 500,000

Reference 2

CAPITAL PLAN DETAIL FY2024-FY2028	FUNDING SOURCE	LIFE (YRS)	2024	2025	2026	2027	2028	TOTAL
PUBLIC WORKS ADMINISTRATION				**$ 1,500,000**	**$ 50,000**	**$ 850,000**		**$ 2,400,000**
LED Streetlight Replacement	BOND	10				$ 850,000		$ 850,000
Solid Waste Trash and Recycling Toters	BOND	10		$ 750,000				$ 750,000
Solid Waste Trash and Recycling Toters	OTHER			$ 750,000				$ 750,000
Town Wide Aerial Imagery	CASH				$ 50,000			$ 50,000
PUBLIC WORKS CEMETERY DIVISION			**$ 75,000**	**$ 10,000**	**$ 10,000**	**$ 10,000**	**$ 10,000**	**$ 115,000**
Headstone Cleaning & Repair	OTHER		$ -	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 40,000
Mini-Excavator	OTHER		$ 75,000					$ 75,000
PUBLIC WORKS ENGINEERING DIVISION					**$ 25,000**		**$ 25,000**	**$ 50,000**
Roadway Consulting Services	CASH				$ 25,000		$ 25,000	$ 50,000
PUBLIC WORKS HIGHWAY DIVISION		21	$ 2,935,211	$ 3,059,217	$ 3,000,685	$ 3,153,127	$ 3,082,555	$ 15,230,795
1 Ton Dump Truck w-Plow-Sander	CASH			$ 85,000		$ 90,000		$ 175,000
10 Wheel Dump Truck.	BOND	7	$ 165,000					$ 165,000
3/4 Ton Pickup	CASH			$ 68,000			$ 72,000	$ 140,000
44,000 GVW, 4WD Truck w-Dump Body	BOND	7		$ 220,000				$ 220,000
44,000 GVW, 4WD Truck w-Sander	BOND	7	$ 215,000		$ 220,000	$ 225,000		$ 660,000
Accessibility Improvements (Override 2019)	CASH		$ 215,378	$ 220,763	$ 226,282	$ 231,939	$ 237,737	$ 1,132,099
Asphalt Pavement Hot Box	CASH			$ 50,000				$ 50,000
Asphalt Pavement Roller	CASH						$ 50,000	$ 50,000
Chapter 90 Roadway	OTHER		$ 760,000	$ 760,000	$ 760,000	$ 760,000	$ 760,000	$ 3,800,000
Install Sidewalk Ramps - CDBG	OTHER		$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 625,000
Roadway Reconstruction	CASH		$ 367,000	$ 385,000	$ 395,000	$ 420,000	$ 470,000	$ 2,037,000
Roadway Reconstruction Override 2011	CASH		$ 524,833	$ 537,954	$ 551,403	$ 565,188	$ 579,318	$ 2,758,696
Sander Body	CASH		$ 18,000	$ 18,000	$ 18,000	$ 18,500	$ 18,500	$ 91,000
Sidewalk Ramp Installation	CASH		$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 325,000
Sidewalks and Curbstones	CASH		$ 430,000	$ 430,000	$ 580,000	$ 580,000	$ 580,000	$ 2,600,000
Snow Plow Replacement	CASH			$ 12,500		$ 12,500		$ 25,000
Traffic Signal Upgrades	CASH		$ 50,000	$ 30,000	$ 60,000	$ 60,000	$ 60,000	$ 260,000
Utility Truck (2)	CASH			$ 52,000			$ 65,000	$ 117,000

Reference 2

CAPITAL PLAN DETAIL FY2024-FY2028	FUNDING SOURCE	LIFE (YRS)	2024	2025	2026	2027	2028	TOTAL
PUBLIC WORKS NATURAL RESOURCES DIVISION			**$ 78,000**	**$ 175,000**	**$ 119,000**	**$ 184,500**	**$ 380,000**	**$ 936,500**
1 Ton Pickup Truck w-Dump Body	CASH		$ 78,000		$ 79,000			$ 157,000
3/4 Ton Pickup (1 w/liftgate, 1 w/plow)	CASH					$ 68,000	$ 70,000	$ 138,000
Enclosed Trailer	CASH					$ 14,500		$ 14,500
Infield Machine	CASH						$ 35,000	$ 35,000
Large Chipper w/ grapple	BOND	7					$ 275,000	$ 275,000
Mower 60" Deck	CASH					$ 20,000		$ 20,000
Mower 72" Deck	CASH					$ 40,000		$ 40,000
Ride-On Mower	CASH					$ 42,000		$ 42,000
Skid Steer	CASH			$ 75,000				$ 75,000
Stump Grinder	CASH			$ 60,000				$ 60,000
Utility Vehicles (2)	CASH			$ 40,000	$ 40,000			$ 80,000
PUBLIC WORKS WATER/SEWER DIVISION			**$ 2,975,000**	**$ 2,950,000**	**$ 3,006,000**	**$ 3,015,000**	**$ 4,100,000**	**$ 16,046,000**
6" High Capacity Pump	OTHER			$ -		$ 45,000		$ 45,000
Drainage Rehab - Regulatory Compliance (Ch-308)	OTHER		$ 400,000	$ 450,000	$ 450,000	$ 450,000	$ 450,000	$ 2,200,000
Hydrant and Valve replacement program	OTHER		$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 500,000
Pump Station Generator	OTHER		$ 75,000					$ 75,000
Sewer System Rehabilitation	OTHER		$ 900,000	$ 900,000	$ 900,000	$ 900,000	$ 1,000,000	$ 4,600,000
Trench Box	OTHER					$ 20,000		$ 20,000
Utility Truck	OTHER				$ 56,000			$ 56,000
Vacuum/Jet Truck	OTHER	7					$ 550,000	$ 550,000
Water System Rehabilitation	OTHER		$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 2,000,000	$ 8,000,000
PURCHASING			**$ 64,918**	**$ 58,800**	**$ 51,200**	**$ 40,500**	**$ 75,300**	**$ 290,718**
Photocopier Replacement Program	CASH		$ 64,918	$ 58,800	$ 51,200	$ 40,500	$ 75,300	$ 290,718
RECREATION			**$ 205,000**	**$ 635,000**	**$ 385,000**	**$ 735,000**	**$ 135,000**	**$ 2,095,000**
ADA Study Implementation Program	CASH		$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 250,000
Ed Burns Arena Parking Study	CASH		$ 75,000					$ 75,000
Feasibility Study	CASH		$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 50,000
Parallel Park	BOND	15		$ 500,000				$ 500,000
Playground Audit and Safety Improvements	CASH		$ 70,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 370,000
Thorndike Field Design	BOND	5			$ 250,000			$ 250,000
Waldo Park Playground Renovaton	BOND	15				$ 600,000		$ 600,000

Reference 2

CAPITAL PLAN DETAIL FY2024-FY2028

	FUNDING SOURCE	LIFE (YRS)	2024	2025	2026	2027	2028	TOTAL
SCHOOLS			**$ 3,156,000**	**$ 2,226,000**	**$ 2,719,000**	**$ 309,000**	**$ 205,000**	**$ 8,615,000**
All Schools - Ceiling Tile Replacement	CASH			$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 40,000
All Schools - Energy Efficiency Projects	CASH		$ 31,000	$ 31,000	$ 54,000	$ 54,000	$ -	$ 170,000
All Schools - Flooring	CASH		$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 125,000
All Schools - Photocopier Lease Program	CASH		$ 120,000	$ 120,000	$ 120,000	$ 120,000	$ 120,000	$ 600,000
All Schools - Security Updates	CASH		$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 250,000
Arlington High School and Ottoson Middle School - Radios	CASH		$ 70,000					$ 70,000
Bishop School - Front Office Reconfiguration	BOND	20		$ 200,000				$ 200,000
Bishop School Envelope - Window, Masonry	BOND	20		$ 500,000				$ 500,000
Bishop School Roof Replacement	BOND	20	$ 1,600,000					$ 1,600,000
Bishop School RTUs, EMS Upgrades	OTHER		$ 150,000					$ 150,000
Brackett School Playground Renovation	BOND	15		$ 800,000				$ 800,000
Bus #101 Replacement	BOND	5			$ 110,000			$ 110,000
Bus #108 Replacement	BOND	5			$ 100,000			$ 100,000
Dallin School RTUs, EMS Upgrades, Boilers	OTHER		$ 80,000					$ 80,000
Facilities Vehicle Replacement	CASH		$ 50,000	$ -	$ 50,000	$ 50,000		$ 150,000
Gibbs School Additional Classrooms	BOND	20	$ 100,000					$ 100,000
Gibbs School Outdoor Multipurpose Space	BOND	10		$ 100,000				$ 100,000
Hardy School Envelope Repairs - Window, Masonry	BOND	20			$ 2,200,000			$ 2,200,000
Hardy School RTUs, EMS Upgrades, Boilers	OTHER		$ 450,000					$ 450,000
Ottoson Middle School Gym Divider	CASH		$ 45,000					$ 45,000
Ottoson Middle School Public Address System & Clock Replacements	CASH		$ 50,000					$ 50,000
Peirce School RTUs, EMS Upgrades, Boilers	BOND	10		$ 300,000				$ 300,000
Stratton School Main Lobby Renovation and Office Additions	CASH			$ 50,000				$ 50,000
Thompson School Air Conditioning	OTHER		$ 260,000					$ 260,000
Thompson School Outdoor Classroom Project/Reforesting Project	OTHER		$ 75,000					$ 75,000
Van # 109 - 8 Passenger Explorer	CASH			$ 40,000				$ 40,000
TOWN MANAGER			**$ 50,000**					**$ 50,000**
Big Belly Solar-Powered Trash Compactors	OTHER		$ 50,000					$ 50,000
GRAND TOTAL			**$ 13,385,126**	**$ 13,275,704**	**$ 13,107,059**	**$ 10,511,080**	**$ 10,738,323**	**$ 61,017,292**

TOWN OF ARLINGTON
CAPITAL PLAN FY2024-FY2028

New Debt Service FY2024-FY2028

	LIFE (YRS)	2024	2025	2026	2027	2028	Total
COMMUNITY SAFETY - FIRE SERVICES		**$ -**	**$ 81,250**	**$ 78,125**	**$ 141,938**	**$ 246,727**	**$ 548,040**
Rescue Ambulance replacing #1026	6	$ -	$ 81,250	$ 78,125	$ 75,000	$ 71,875	$ 306,250
Rescue Ambulance replacing #1032	6	$ -	$ -	$ -	$ -	$ 86,667	$ 86,667
Vehicle Replacement - #1005 2008 Seagrave Pumper	10	$ -	$ -	$ -	$ -	$ -	$ -
Headquarters - Mechanical System Replacement	15	$ -	$ -	$ -	$ -	$ 23,479	$ 23,479
Highland - Mechanical System Replacement	10	$ -	$ -	$ -	$ 66,938	$ 64,706	$ 131,644
FACILITIES		**$ -**	**$ 20,000**	**$ 19,500**	**$ 19,000**	**$ 18,500**	**$ 77,000**
Central School building envelope repairs	20	$ -	$ 20,000	$ 19,500	$ 19,000	$ 18,500	$ 77,000
HEALTH & HUMAN SERVICES		**$ -**	**$ 72,000**	**$ 78,968**	**$ 157,699**	**$ 153,661**	**$ 462,327**
Veterans Memorial Park	20	$ -	$ 20,000	$ 28,268	$ 108,299	$ 105,561	$ 262,127
Whittemore Robbins Estate Rehab	20	$ -	$ 52,000	$ 50,700	$ 49,400	$ 48,100	$ 200,200
LIBRARY		**$ -**	**$ 21,941**	**$ 21,209**	**$ 20,478**	**$ 19,746**	**$ 83,374**
Robbins Library Lighting Project	10	$ -	$ 21,941	$ 21,209	$ 20,478	$ 19,746	$ 83,374
PLANNING		**$ -**	**$ 19,367**	**$ 18,813**	**$ 18,260**	**$ 17,707**	**$ 74,147**
Community Center Elevator Replacement	15	$ -	$ 19,367	$ 18,813	$ 18,260	$ 17,707	$ 74,147
PUBLIC WORKS ADMINISTRATION		**$ -**	**$ -**	**$ 112,500**	**$ 108,750**	**$ 232,500**	**$ 453,750**
LED Streetlight Replacement	10	$ -	$ -	$ -	$ -	$ 127,500	$ 127,500
Solid Waste Trash and Recycling Toters	10	$ -	$ -	$ 112,500	$ 108,750	$ 105,000	$ 326,250
PUBLIC WORKS HIGHWAY DIVISION		**$ -**	**$ 73,286**	**$ 113,000**	**$ 151,143**	**$ 188,679**	**$ 526,107**
10 Wheel Dump Truck.	7	$ -	$ 31,821	$ 30,643	$ 29,464	$ 28,286	$ 120,214
44,000 GVW, 4WD Truck w-Dump Body	7	$ -	$ -	$ 42,429	$ 40,857	$ 39,286	$ 122,571
44,000 GVW, 4WD Truck w-Sander	7	$ -	$ 41,464	$ 39,929	$ 80,821	$ 121,107	$ 283,321
PUBLIC WORKS NATURAL RESOURCES DIVISION		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Large Chipper w/ grapple	7	$ -	$ -	$ -	$ -	$ -	$ -
RECREATION		**$ -**	**$ -**	**$ 58,333**	**$ 119,167**	**$ 185,000**	**$ 362,500**
Parallel Park	15	$ -	$ -	$ 58,333	$ 56,667	$ 55,000	$ 170,000
Thorndike Field Design	5	$ -	$ -	$ -	$ 62,500	$ 60,000	$ 122,500
Waldo Park Playground Renovaton	15	$ -	$ -	$ -	$ -	$ 70,000	$ 70,000
SCHOOLS		**$ -**	**$ 170,000**	**$ 389,083**	**$ 650,917**	**$ 632,650**	**$ 1,842,650**
Bishop School - Front Office Reconfiguration	20	$ -	$ -	$ 20,000	$ 19,500	$ 19,000	$ 58,500
Bishop School Envelope - Window, Masonry	20	$ -	$ -	$ 50,000	$ 48,750	$ 47,500	$ 146,250

Reference 3

New Debt Service FY2024-FY2028	LIFE (YRS)	2024	2025	2026	2027	2028	Total
Bishop School Roof Replacement	20	$ -	$ 160,000	$ 156,000	$ 152,000	$ 148,000	$ 616,000
Brackett School Playground Renovation	15	$ -	$ -	$ 93,333	$ 90,667	$ 88,000	$ 272,000
Bus #101 Replacement	5	$ -	$ -	$ -	$ 27,500	$ 26,400	$ 53,900
Bus #108 Replacement	5	$ -	$ -	$ -	$ 25,000	$ 24,000	$ 49,000
Gibbs School Additional Classrooms	20	$ -	$ 10,000	$ 9,750	$ 9,500	$ 9,250	$ 38,500
Gibbs School Outdoor Multipurpose Space	10	$ -	$ -	$ 15,000	$ 14,500	$ 14,000	$ 43,500
Hardy School Envelope Repairs - Window, Masonry	20	$ -	$ -	$ -	$ 220,000	$ 214,500	$ 434,500
Ottoson Middle School Envelope Repairs	20	$ -	$ -	$ -	$ -	$ -	$ -
Peirce School RTUs, EMS Upgrades, Boilers	10	$ -	$ -	$ 45,000	$ 43,500	$ 42,000	$ 130,500
GRAND TOTAL		**$ -**	**$ 457,843**	**$ 889,532**	**$ 1,387,350**	**$ 1,695,169**	**$ 4,429,894**

Reference 4

CAPITAL BUDGET 2024	BOND	CASH	OTHER	Grand Total
CLERK'S OFFICE		**$ 26,791**		**$ 26,791**
New Voting Booths		$ 26,791		$ 26,791
COMMUNITY SAFETY - FIRE SERVICES	**$ 375,000**	**$ 50,000**	**$ 175,000**	**$ 600,000**
Firefighter Protective Gear		$ 30,000		$ 30,000
LUCAS 3 - Chest Compression System		$ 20,000		$ 20,000
Rescue Ambulance replacing #1026	$ 375,000			$ 375,000
Park Circle - Mechanical System Replacement			$ 175,000	$ 175,000
COMMUNITY SAFETY - POLICE SERVICES		**$ 190,133**	**$ 272,000**	**$ 462,133**
Bola Wrap De-Escalation Tools		$ 15,000		$ 15,000
Bullet Proof Vest Program			$ 22,000	$ 22,000
Cooling Tower			$ 250,000	$ 250,000
QED Server		$ 15,133		$ 15,133
Vehicle Replacement Program		$ 160,000		$ 160,000
FACILITIES	**$ 200,000**	**$ 75,000**		**$ 275,000**
Central School building envelope repairs	$ 200,000			$ 200,000
Town Hall - Renovations		$ 75,000		$ 75,000
HEALTH & HUMAN SERVICES	**$ 720,000**			**$ 720,000**
Veterans Memorial Park	$ 200,000			$ 200,000
Whittemore Robbins Estate Rehab	$ 520,000			$ 520,000
INFORMATION TECHNOLOGY		**$ 797,000**	**$ 70,000**	**$ 867,000**
Application Modernization Initiative			$ 40,000	$ 40,000
Conference Room Presentation Technology Program			$ 30,000	$ 30,000
School - Admin Computers and Peripherals		$ 60,000		$ 60,000
School - Network Infrastructure		$ 80,000		$ 80,000
School - Replacement academic PC's district wide		$ 400,000		$ 400,000
School - Software Licensing		$ 40,000		$ 40,000
Town Microcomputer Program		$ 62,000		$ 62,000
Town Software Upgrades & Standardization		$ 155,000		$ 155,000
LIBRARY	**$ 146,270**	**$ 130,803**	**$ 22,000**	**$ 299,073**
Energy Management System		$ 77,000		$ 77,000
MLN Equipment Schedule		$ 53,803	$ 22,000	$ 75,803
Robbins Library Lighting Project	$ 146,270			$ 146,270
PLANNING	**$ 166,000**	**$ 205,000**	**$ 225,000**	**$ 596,000**
Community Center Air Handler Replacement			$ 225,000	$ 225,000
Community Center Elevator Replacement	$ 166,000			$ 166,000
Design and engineering consultants		$ 75,000		$ 75,000
Electrification and air quality master planning		$ 30,000		$ 30,000
Townwide ADA acccessibility upgrades		$ 100,000		$ 100,000

Reference 4

CAPITAL BUDGET 2024	BOND	CASH	OTHER	Grand Total
PUBLIC WORKS CEMETERY DIVISION			**$ 75,000**	**$ 75,000**
Mini-Excavator			$ 75,000	$ 75,000
PUBLIC WORKS ENGINEERING DIVISION				**$ -**
PUBLIC WORKS HIGHWAY DIVISION	$ 380,000	$ 1,670,211	$ 885,000	$ 2,935,211
10 Wheel Dump Truck.	$ 165,000			$ 165,000
44,000 GVW, 4WD Truck w-Sander	$ 215,000			$ 215,000
Accessibility Improvements (Override 2019)		$ 215,378		$ 215,378
Chapter 90 Roadway			$ 760,000	$ 760,000
Install Sidewalk Ramps - CDBG			$ 125,000	$ 125,000
Roadway Reconstruction		$ 367,000		$ 367,000
Roadway Reconstruction Override 2011		$ 524,833		$ 524,833
Sander Body		$ 18,000		$ 18,000
Sidewalk Ramp Installation		$ 65,000		$ 65,000
Sidewalks and Curbstones		$ 430,000		$ 430,000
Traffic Signal Upgrades		$ 50,000		$ 50,000
PUBLIC WORKS NATURAL RESOURCES DIVISION		**$ 78,000**		**$ 78,000**
1 Ton Pickup Truck w-Dump Body		$ 78,000		$ 78,000
PUBLIC WORKS WATER/SEWER DIVISION			**$ 2,975,000**	**$ 2,975,000**
Drainage Rehab - Regulatory Compliance (Ch-308)			$ 400,000	$ 400,000
Hydrant and Valve replacement program			$ 100,000	$ 100,000
Pump Station Generator			$ 75,000	$ 75,000
Sewer System Rehabilitation			$ 900,000	$ 900,000
Water System Rehabilitation			$ 1,500,000	$ 1,500,000

Reference 4

CAPITAL BUDGET 2024	BOND	CASH	OTHER	Grand Total
PURCHASING		**$ 64,918**		**$ 64,918**
Photocopier Replacement Program		$ 64,918		$ 64,918
RECREATION		**$ 205,000**		**$ 205,000**
ADA Study Implementation Program		$ 50,000		$ 50,000
Ed Burns Arena Parking Study		$ 75,000		$ 75,000
Feasibility Study		$ 10,000		$ 10,000
Playground Audit and Safety Improvements		$ 70,000		$ 70,000
SCHOOLS	**$ 1,700,000**	**$ 441,000**	**$ 1,015,000**	**$ 3,156,000**
All Schools - Energy Efficiency Projects		$ 31,000		$ 31,000
All Schools - Flooring		$ 25,000		$ 25,000
All Schools - Photocopier Lease Program		$ 120,000		$ 120,000
All Schools - Security Updates		$ 50,000		$ 50,000
Arlington High School and Ottoson Middle School - Radios		$ 70,000		$ 70,000
Bishop School Roof Replacement	$ 1,600,000			$ 1,600,000
Bishop School RTUs, EMS Upgrades			$ 150,000	$ 150,000
Dallin School RTUs, EMS Upgrades, Boilers			$ 80,000	$ 80,000
Facilities Vehicle Replacement		$ 50,000		$ 50,000
Gibbs School Additional Classrooms	$ 100,000			$ 100,000
Hardy School RTUs, EMS Upgrades, Boilers			$ 450,000	$ 450,000
Ottoson Middle School Gym Divider		$ 45,000		$ 45,000
Ottoson Middle School Public Address System & Clock Replacements		$ 50,000		$ 50,000
Thompson School Air Conditioning			$ 260,000	$ 260,000
Thompson School Outdoor Classroom Project/Reforesting Project			$ 75,000	$ 75,000
TOWN MANAGER			**$ 50,000**	**$ 50,000**
Big Belly Solar-Powered Trash Compactors			$ 50,000	$ 50,000
GRAND TOTAL	**$ 3,687,270**	**$ 3,933,856**	**$ 5,764,000**	**$ 13,385,126**

Responses to Finance Committee Member Questions on the FY2024 Capital Planning Committee Report

#	FinCom Member	Category	Question	Response
1. .	Jennifer	Recreation	Are there generally accepted estimates for the useful life of a playground?	Depends on age, usage, damage, safety issues, etc. The cost estimates also very much depend on the size of the playground itself and the exact specifications - whether we're just including play equipment or also doing blacktop, for example. And the footprint of one playground to the next varies greatly. Larger footprints are going to be a lot more expensive because of that rubberized surfacing. The cost estimates we've received have also very much dependent on the time that we go out to bid for these projects.
2.	Annie		Why is there no new debt service for FY'24	We typically borrow for projects in the following fiscal year. You'll see debt service beginning for the fiscal 24 projects in fiscal 25. For example, in December we borrowed for everything that was approved at last town meeting. So those are the fiscal 23 projects. We won't start paying debt service on these projects until December 2023 which is fiscal 24. When we were putting the capital plan together, we had already done the borrowing so we were able to fold these new debt service costs into the "existing debt" line.
3.	Jennifer	Schools	What about Ottoson projects?	Because of the anticipated Ottoson rebuild, APS withdrew most requests and only urgent projects were included in the plan.
4.	Topher	Schools	Do we have a sense of the timing of an Ottoson rebuild?	Based upon conversations between Timur Yontar and Liz Homan, APS Superintendent: OMS rebuild is intended to happen as soon after the AHS rebuild as possible. It has to be after because the project will be too costly to do without MSBA matching funds, and they won't match another Arlington large project until AHS is wrapping up.
5.	Topher	Facilities	What is the 'Town Hall envelope study'? Does 'envelope' mean the entire Town Hall complex?	The "envelope" is the shell of a building that separates usable interior from exterior elements. We did a study

Responses to Finance Committee Member Questions on the FY2024 Capital Planning Committee Report

#	FinCom Member	Category	Question	Response
				on what work is needed for this at Town Hall. Julie is working on getting a copy of that report to us. Julie obtained this study which is included in an FY24 CPA application and is on SharePoint here: Related Reports.
6.	Topher		BAN = bond anticipation note?	Yes
7.	Topher	Public Works Highway Division	Where can I get a copy of the '2019 Pavement Management Report'.	Mike Rademacher, Director of DPW provided these comments as context for the 2019 Pavement report. "We will be looking to update the Pavement Management Report as it will be 5 years old next FY and we have a five year cycle of revisiting this data. I believe the expense recommendations are listed on page 11. The sidewalk study was done to help identify the sidewalk/ramp conditions to help direct where we perform work. It does not recommend an annual funding but rather lists the totals need for improvement. This document was used to help increase the annual budget but as you will see, the $500k± requested annually does not make a big dent in the backlog. I believe the Connect Arlington plan used the data from this report." Mike sent the Pavement and a Sidewalk Survey report both of which I put on the FinCom SharePoint site here: Related Reports.

Responses to Finance Committee Member Questions on the FY2024 Capital Planning Committee Report

#	FinCom Member	Category	Question	Response
8.	Topher	Recreation	Are there any concrete plans to put AstroTurf on a field in next 5 years? (We have a citizen warrant article on this)	From Joe Connelly, Director of Recreation: "Town Manager currently has a moratorium on designing any turf fields. That said, there is a town-wide discussion on April 11 to discuss whether the Town wants turf fields. The Park and Rec Commission does want a turf field at Poet's Corner, which would be paid for by the Belmont Hill School. Were this project to move forward, the field would be installed in approximately 2-2.5 years."
9.	Charlie	Schools	What do the acronyms "RTU" and "EMS" stand for?	RTU stands for "Rooftop Unit" (HVAC) and EMS is an "Energy Management System.
10.	Dean	Recreation	In December 2018 Town Manager Adam Chapdelaine issued a memo (attached) addressing the loss of the open space at what was known as "Pierce Practice". As one possible solution he pointed to "4b.Exploring potential use of the Town owned parcel on Ryder Street (currently rented to Lalicata Landscaping) as a soccer/lacrosse field". This would have to be a capital project. How is the exploration going?	Timur consulted with the Town Manager's office and received, *"No plans to use Ryder Street for a playing field at this time. I don't think we would in the future."*
11.	Jennifer	Public Works Highway Division	There is **$891,833** for Roadway Reconstruction and **$495,000** for sidewalks, curbstones, and ramps. What is the **$215,378** for Accessibility Improvements (note says that it from the 2019 override)? Is that also for sidewalks or is that for something else?	Accessibility improvements is broadly termed "pedestrian infrastructure" with an emphasis on "sidewalk brick removal and repair." It was one component of a commitment the Select Board made in April 2019, in advance of the override vote: "Improve mobility for all residents, and support the goals of the Town's Complete Streets and Age-Friendly Community initiatives by adding $250,000 to the base budget for pedestrian infrastructure -- including

Responses to Finance Committee Member Questions on the FY2024 Capital Planning Committee Report

#	FinCom Member	Category	Question	Response
				sidewalk brick removal and repair -- and senior transportation, such investments to be guided by the Town's sustainable mobility planning efforts." The $250 K is split $200 K to capital for accessibility improvements (which first took effect in the FY2021 Capital Budget, and which escalates by +2.5% each year) and $50 K to operating for senior transportation.
Capital Plan				
12.	Charlie	Community Safety – Fire Services	Why is the ambulance not being funded by the ambulance revolving fund?	a. Ambulance Fund can only pay ambulance cost if there is a sufficient balance. There currently isn't and based upon the billing change (see #12b), there isn't expected to be, hence a new practice. *b.* [From Town Manager's Office ("TMO")] *Due to a change in billing, most of the ambulance revenue is coming into the General Fund and not the Ambulance Fund. To still be able to "use" some of that revenue in the capital plan, we are adjusting the plan and pulling the debt service for the ambulance in FY24 out of the 5% calculation. This is a change from prior practice of tapping the ambulance fund as an offset to pay for this debt service.*
13.	Charlie & Jennifer	Community Safety – Police Services	Why are buying a new cooling tower? Who is funding? How was this missed in the CSB renovation?	a. CS Building constructed 1983, renovated 2017. b. Current assessment of Facilities Dept: during CSB rebuild, cooling system was undersized/underpowered for scale of building. c. APD (which operates inside the building) concurs with assessment: building too hot in summer. d. Funding with ARPA for HVAC.
14.	Charlie	Facilities	Central School Envelope: is this an overrun on the Community Center Project?	No, it's a planning study for future capital work to be done here on the building envelope.
15.	Charlie	Facilities	What is the rental income and costs for town-owned buildings?	[From TMO] *There's currently very little income as the Town continues to need to use the buildings for staff. We have a warrant article in to bring the three ARB*

Responses to Finance Committee Member Questions on the FY2024 Capital Planning Committee Report

#	FinCom Member	Category	Question	Response
				properties back into the general fund, as this fund is no longer able to bring in enough rent to cover the cost of operating the buildings. We'll continue to use what rent revenue we can to cover the debt service for these buildings.
16.	Charlie	Planning	What is the electrification and air quality master plan? Why is it a capital expense?	It's a planning study for future capital work to electrify town buildings (to achieve net-zero) and to improve air quality.
17.	Charlie	Public Works Water/Sewer Division	Is the new water meter reading system completely installed and operating?	No, due to supply chain issues.
18.	Charlie	Schools	What are the AHS and Ottoson radios?	For internal communication in case of an emergency.
19.	Charlie	Schools	Why are we spending $260,0000 on Thompson School air conditioning? Was not the school recently renovated and expanded?	a. Thompson ES rebuilt 2013, with addition 2017. b. During rebuild, CPC declined to pay for A/C. c. School is in use during summer months.
20.	Charlie	Schools	What is the other account paying for the big-belly solar compactors?	Parking Benefits District.
21.	Jennifer	Facilities	Why are we replacing the Community Center elevator?	The elevator was not replaced during the recent building renovation. Initially installed in 1982, the elevator is frequently out of service and long past the typical lifespan (~20 years) of elevator equipment. As a result, it has become difficult to ensure ADA access to programs and services in the building. With many classes, programming and services for seniors, along with the many public events held in the building, it is vital that the Community Center has an operating elevator.
Capital Budget				
22.	Charlie	Community Safety – Fire Services	2027 Ambulance: Why not revolving fund?	See #12.
23.	Charlie	Community Safety – Fire Services	2026 Highland Fire Station: What is the mechanical System? Was the building not recently renovated? Has this not been maintained?	a. Highland FS built 1929, renovated 2011, >10y ago. b. Mechanical system is combination of 2 Boilers, HW tank, RTUs. c. Even with maintenance, systems wear out.

Responses to Finance Committee Member Questions on the FY2024 Capital Planning Committee Report

#	FinCom Member	Category	Question	Response
				d. New system needed per assessment of Facilities Dept. e. Future anticipated life of system 10y.
24.	Charlie	HHS	2024-2026 Veterans Memorial Park: How is this being funded?	a. In final Capital Plan: BOND FY24 $200 K, FY25 $87,677, FY26 $807,500; OTHER FY25 $800 K, FY26 $950 K b. BOND FY24 is planning study for future capital work c. OTHER will be various fundraising sources (see below); if not raised, Town will not contribute d. Sources include: State earmark, CDBG application, Parking Benefits District request, State ADA grant, Federal earmark, and donations
25.	Charlie	IT	2024-2028 IT Software Upgrades and Standardization. Is not this supposed to be an operating expense like the other licenses?	a. CPC has requested to move operating costs like licenses to Operating budget. b. In FY24, we moved MLN licenses at $22K, new apps and permits licensing $40K. c. We were told there was no more room; we would be happy to offload more next year.
26.	Charlie	Planning	2027 Blue Bikes: Do we have a usage and cash flow accounting for the Blue Bike Program?	Planning will be providing data prior to the next capital cycle.
27.	Charlie	Planning	2024-2028 Electrification and Air Quality Master Planning. How can this be capital when we don't know what it is for? This an Operating expense, and maybe an expense we should not undertake at all.	See #16 above
28.	Charlie	Public Works/Admin	2025 Solid Waste Toters: Is there an ROI on this? How do we protect the assets? Isn't this like football helmets or team uniforms? How is this capital? What is the useful life?	*a.* [From TMO] *Having toters will help make our bid for a new trash contract more competitive. The reason for it is more waste haulers are moving in this direction. Even our current company would like us to have them. Wouldn't change our current contract but sets us up for more advantageous bid when we go out to bid in three years. We're more limited with manual trash.*

Responses to Finance Committee Member Questions on the FY2024 Capital Planning Committee Report

#	FinCom Member	Category	Question	Response
				b. Likely go to a smaller barrel (charging for an overflow bag). Proposing for future attractive bids and that the Recycling Coordinator hears a lot – cleaner, neater, reducing rat access to trash because it has a lid. *c. We haven't run any scenarios with cost savings. We're planning to do that next year for the upcoming capital year. This will likely help us control cost increases that we're likely going to see in the next contract.*
29.	Charlie	Recreation	Recreation Parks and Playgrounds: Why are the prices so low? Allegedly they were rising to $900k or more?	a. CPC has told Rec, "You have to live within means", i.e. there is only so much to be spent on playgrounds. b. Additionally, the amount varies by playground.
30.	Charlie	Schools	School Energy Efficiency: What are these projects?	LED lighting upgrades district-wide
31.	Charlie	Schools	2025 Bishop School: Envelope / roof replacement? How old are these?	a. Bishop ES built 1950, renovated 2002, >20y ago. b. Even with maintenance, envelopes & roofs wear out. c. Envelope & roof work needed per assessment of Facilities Dept. d. Future anticipated life 20y.
32.	Charlie	Schools	2026 Hardy Envelope: Wasn't Hardy renovated and expanded? Why this huge expense?	a. Built 1926, renovated 2001, >20y ago. (With addition 2018.) b. Even with maintenance, envelopes wear out. c. Envelope work needed per assessment of Facilities Dept. d. Future anticipated life 20y.

Reference 6

APPENDIX A
SCOPING STUDY NARRATIVE

HVAC Concept Narrative

Two options are being considered to convert the natural gas-fired systems to electrified systems for each of the six schools.

OPTION 1

Air-Cooled Variable Refrigerant Flow (VRF) HVAC System

This option consists of indoor cassette units, fan coils, etc. with outdoor VRF compressor units and interconnecting refrigerant piping for zone heating/cooling control. Refer to the HVAC concept plans for the quantity and location of the individual heat pumps. Cutsheets are located in Appendix B.

OPTION 2

Geothermal HVAC System

This option consists of unitary water-source heat pumps for zone heating/cooling control and an underground closed loop geothermal wellfield. Refer to the HVAC concept plans for the quantity and location of the individual heat pumps and wellfield site scope. Cutsheets are located in Appendix B.

Common Ventilation Systems

In response to COVID-19, both options include dedicated ventilation (outside) air systems to deliver preconditioned and highly filtered fresh air to all occupiable spaces. The ventilation air is de-coupled from the HVAC heating and cooling with spaces or zones receiving outside air separately or ducted into the heat pumps utilizing demand control ventilation via a VAV air terminal and CO2/occupancy control. Generally, there is one outside air handling unit with energy recovery for ventilation except for Ottoson Middle School which requires multiple units. System sizing will comply with ASHRAE 62.1 and/or IMC. Cutsheets are located in Appendix B.

Demolition

All existing equipment shall be completely removed from the building unless otherwise noted.

Exceptions

All supply and return is to be demoed except for that in the gyms. All exhaust ductwork shall remain. The proposed design utilizes existing ductwork where possible. The new systems would require additional ductwork to connect existing distribution and create the common duct for the DOAS but, this would be a fraction of total duct. The percentage of repurposed from existing verses new ductwork is noted below for each of the schools.

a. Bishop Elementary School – 40% existing / 60% new
   - Existing exhaust ductwork and risers shall remain and be resealed and reused
b. Brackett Elementary School – 40% existing / 60% new
c. Dallin Elementary School – 40% existing / 60% new
d. Hardy Elementary School – 40% existing / 60% new
e. Peirce Elementary School – 40% existing / 60% new
f. Ottoson Middle School – 15% existing / 85% new

OPTION 1: Air-Cooled Variable Refrigerant Flow (VRF) HVAC System

This option consists of indoor cassette units, fan coils, etc. with outdoor VRF compressor units and interconnecting refrigerant piping for zone heating/ cooling control. Cutsheets are located in Appendix B.

The building shall be heated and cooled by a cold-climate Variable Refrigerant Flow (VRF) System, consisting of air-cooled heat recovery type outdoor units and indoor cassettes, fan coil units and air handlers. The VRF system shall include air-cooled heat recovery units and indoor fan coils units. The heat recovery units shall be located on the roof and/or on grade. The VRF system shall be capable of providing simultaneous heating and cooling. The VRF system shall utilize R-410A refrigerant.

Indoor VRF fan coil units (FCUs) will be either ceiling cassette type, wall mounted type, or ducted, high-static type located in the ceiling plenum directly above the space served. All ducted type units will be provided with filter boxes and MERV 11 filters. All indoor units will be furnished with condensate pump packages if not provided as standard. A wall mounted remote controller will be provided for each fan coil unit. The indoor units will be configured to sense space temperature at the remote controllers versus at the return intake of the units.

The VRF indoor fan coil units shall be served by a combination of single and multi-port branch selector controllers. Individual branch selector units shall be provided for each fan coil unit, unless shown otherwise on plans. An isolation valve assembly shall be provided on each port. The valve assembly shall be UL listed for refrigerant service and shall consist of flared ends, a ball valve, and a Schrader valve. The branch selector controllers will be located in the ceiling plenum central to several units that share the controller.

The VRF air-cooled heat recovery outdoor units shall be located on the roof and/or on grade and piped to their respective branch selector controllers. Unit compressors shall be hermetically sealed, inverter driven, direct vapor injected, DC scroll type. Outdoor units shall be rated for cold climate and shall be dual module systems requiring separate power supplies for each module. The systems shall provide 100% of the nominal heating capacity down to 0F. Outdoor units shall be mounted and secured to 24” rails/stands secured to the roof deck.

For budgetary purposes assume the following system zoning for the VRF:

a. Bishop Elementary School – 1 module @ 10 tons, 3 modules @ 16 tons, 2 modules @ 20 tons
b. Brackett Elementary School – 3 modules @ 16 tons, 3 modules @ 20 tons
c. Dallin Elementary School – 5 modules @ 16 tons, 1 modules @ 20 tons
d. Hardy Elementary School – 2 modules @ 16 tons, 4 modules @ 20 tons
e. Peirce Elementary School – 2 modules @ 16 tons, 3 modules @ 20 tons
f. Ottoson Middle School – 6 modules @ 16 tons, 7 modules @ 20 tons

The typical classrooms will utilize ceiling mounted cassette-type VRF units. Where fan coil style units are used, they shall have fully ducted supply and return sheet metal ductwork. All supply air ductwork shall be insulated with 2.2” thick, ¾ pcf duct wrap with vapor barrier (installed R-value R>6). Return air ductwork will not be insulated. Each unit will include a duct-mounted pre-filter rack. The pre-filters shall be 24”x24” (4” deep) Astropleat MERV 11. Each heat pump shall include integral disconnect. Condensate for each unit will be disposed of through and floor drain, open receptacle, or condensate pump into the sanitary system.

Each zone shall be provided with factory standard thermostats selected. Additionally, a factory controls intelligent management system shall provide a central location for monitoring and troubleshooting, as well as a BACNet server license to integrate into the BMS.

Additionally, for fan coil units serving the gymnasium, cafeteria, kitchen, art classroom and media center will utilize duct-mounted UV lights and unit-mounted non-ozone (UL 2998 zero-ozone certified) generating bipolar ionization to provide odor control and reduce OA demand.

For budgetary purposes assume the following for the ducted fan coil units:

- 1 ton unit – 400 cfm @ 12x12 SA/RA
- 2-ton unit – 800 cfm @ 14x14 SA/RA
- 3-ton unit – 1,200 cfm @ 16x16 SA/RA
- 4-ton unit – 1,600 cfm @ 18x18 SA/RA
- 5-ton unit – 2,000 cfm @ 20x20 SA/RA
- 6-ton unit – 2,400 cfm @ 22x22 SA/RA

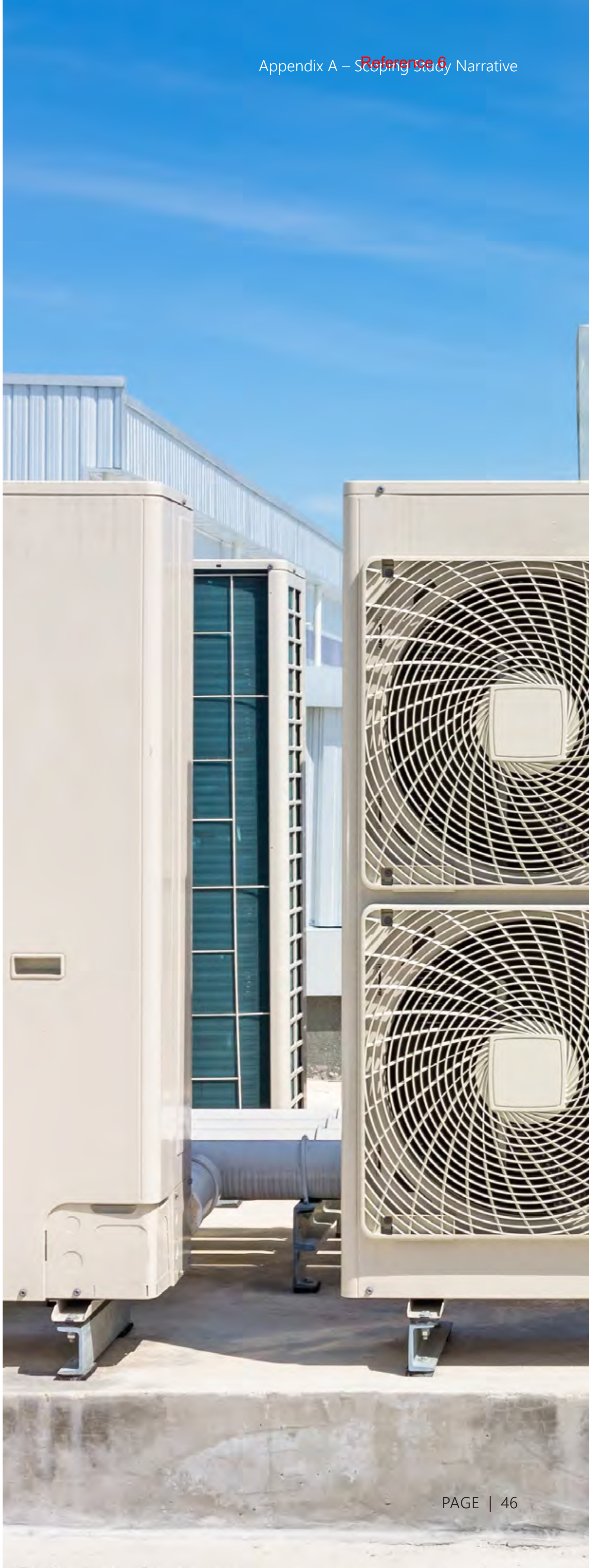
Refrigerant piping between the outdoor units and the branch selection boxes shall by ACR Type “L” hard drawn copper, and all joints should be brazed. Y-joint fittings shall be used to branch the main refrigerant lines where multiple VRF indoor units are served. Piping between the branch selector box and the indoor unit shall be soft copper. All refrigerant piping, whether two pipe system or three pipe system, shall be insulated with 1” thick elastomeric insulation. All exposed indoor piping shall be finished with a PVC jacket. All outdoor refrigerant piping shall be finished with an aluminum jacket with joint on the underside of the piping.

Condensate drains from the indoor units shall be insulated PVC piping with solvent welded joints with traps, vents and unions piped to floor drains, hub drains, or service sinks. The minimum condensate pipe size shall be 3/4”, and easily accessible clean outs shall be provided throughout the piping system. All condensate drain piping shall be insulated with 3/4” thick elastomeric insulation.

24/7 Cooling Areas, such as Elevator Equipment and MDF rooms, shall be conditioned with ductless VRF cassettes.

Small electrical rooms and IDF rooms shall be ventilated with plenum air by transfer air fans.

Electric unit heaters shall be provided at the major points of entry. Assume 10 locations at 3 kW each.



Ventilation Systems

The outside air system for the buildings shall be de-coupled with one outside air unit except for Ottoson Middle School. The dedicated outside air handling units will be modular type (indoor or outdoor depending on the site) and include supply/exhaust plenum fans and utilize double wall construction. The unit shall be variable volume energy recovery type units utilizing building exhaust and general exhaust air to precondition the outside air through desiccant energy recovery wheels.

The air handling equipment shall be Trane, Carrier, Johnson Controls, Daikin, or approved equal, modular air handing units. The outside air unit will generally consist of one (1) dedicated air handling unit sized as noted below with the following sections/components: exhaust air tunnel will be a filter inlet filter/rack, energy recovery device, and two plenum type, exhaust air fans. The outside air tunnel will include an inlet filter, energy recovery device, access, VRF heating/cooling coil with UV lamp, access, two plenum type supply air fans. Each fan will be controlled by a VFD for varying airflow conditions. The exhaust fan is sized at 20% reduction in capacity (thus maintaining building pressurization). The supply air distribution system will supply outside air to VAV terminal units (approx. quantity as noted) for distribution of outside air to each zone.

For budgetary purposes assume the following for the ventilation systems:

a. Ottoson Middle School – 48,000 cfm & 110 VAV terminals
   - Area A: 10,000 cfm
   - Area B: 9,000 cfm
   - Area C: 9,000 cfm
   - Area D: 16,000 cfm
   - Area E: 4,000 cfm
b. Bishop Elementary School – 12,500 cfm & 50 VAV terminals
c. Brackett Elementary School – 14,000 cfm & 49 VAV terminals
d. Dallin Elementary School – 14,000 cfm & 46 VAV terminals
e. Hardy Elementary School – 12,500 cfm & 51 VAV terminals
f. Peirce Elementary School – 11,500 cfm & 41 VAV terminals

In general, outside air shall be provided directly to the spaces with toilet/bathroom/janitors' closet, etc. exhaust being fully ducted and as well as general exhaust from all other spaces. In some cases where noted, the ventilation air shall be provided directly to return-side of the heat pumps and distributed via the heat pump ductwork systems. All conditioned outside air ductwork and building exhaust air ductwork will not be insulated – this applies to positive pressure outside air ductwork and negative pressure exhaust air ductwork. All un-conditioned air ducts shall be insulated with 3" thick, ¾ pcf duct wrap with vapor barrier – this applies to negative pressure outside air ductwork and positive pressure exhaust air ductwork.

For demand control ventilation, classrooms and other appropriate spaces will also include CO2 and occupancy sensors. The thermostat (and associated sensors), CO2 and occupancy sensors are to interface to the building automation system. The CO2 and occupancy sensor inputs will be utilized to control the space ventilation terminal unit and space temperature set points.

To control outside air, a CO2 monitoring will be provided to take advantage of building diversity. Each variable occupied area will contain a CO2 sensor. The VAV terminal will modulate in accordance with the CO2 measurements. The VAV terminal will also be interlocked with new room occupancy sensor. The ventilation rate will be modulated based on occupied and vacant spaces conditions. Where a single terminal serves multiple spaces, the terminal shall control to the highest-demand space.

To further condition and dehumidify the outside air, the system will be provided with a VRF coil connected to an outdoor VRF condensing unit (similar to units described previously in this narrative). The refrigerant piping will be insulated with glass fiber insulation and exterior piping shall be covered with a UV resistant PVC jacket.

For budgetary purposes assume the following for the ventilation systems:

a. Ottoson Middle School
   - 2 x 12-ton
   - 4 x 20-ton
   - 1 x 10-ton
b. Bishop Elementary School – 2 x 16-ton
c. Brackett Elementary School – 2 x 16-ton
d. Dallin Elementary School – 2 x 16-ton
e. Hardy Elementary School – 2 x 16-ton
f. Peirce Elementary School – 2 x 12-ton

Air Distribution

All ductwork shall be galvanized steel constructed to SMACNA's standards. All ductwork joints shall have a sealer applied as dictated by system duct pressure. Ductwork upstream of VAV boxes shall be medium pressure/velocity flat oval type with round runouts to boxes. All medium pressure ductwork shall be pressure tested. Ductwork downstream of the VAV boxes shall be low velocity, rectangular type. All HVAC air distribution systems shall be balanced to AABC standards.

In general, supply air diffusers shall be aluminum construction with a panel face and round neck (Titus OMNI-AA). Linear slot diffusers shall be used along the perimeter wall. Return and exhaust air grilles to be aluminum construction with a ½" egg-grate face mounted in a 24" x 24" lay-in ceiling panel (Titus 50F).

Temperature Control

A web-based BAC-Net DDC controls system shall be provided for the entire building and associated systems. The controls system will also include a JACE panel to communicate (wired/wireless) over the web-based area network. The BAS shall also interface with the building lighting, exterior lighting, and switch gear / electric metering. The system shall be ASHRAE 135 BACnet compliant using BTL listed components.

The VRF manufacturer shall provide a network control system consisting of a centralized system manager, local and remote controllers, and an integrated web-based interface independent from the BAS system. The system shall support operation monitoring, scheduling, error monitor, power distribution, personal browsers, tenant billing, online maintenance support, and integration with the BAS system using BACnet protocol. All available points shall be mapped to the BAS system.

OPTION 2: Geothermal HVAC System

This option consists of unitary water-source heat pumps for zone heating/cooling control and an underground closed loop geothermal wellfield. Refer to the HVAC concept plans for the quantity and location of the individual heat pumps and wellfield site scope. Cutsheets are located in Appendix B.

Geothermal Wellfield & Piping System

The geothermal well field will initially consist of 500 feet deep wells with quantity and circuiting as noted below. The bores will be 6" in diameter and will include a factory-made DR-9, 1-1/4" U-tube, fully grouted well. Individual circuit distribution will route from the mechanical room to the site where possible, otherwise an underground distribution vault will be utilized as noted. The wells shall be installed on a 20-foot minimum spacing. All horizontal mains shall be a minimum of five feet below grade and the trenches shall be 100% back filled with rock or other suitable materials. Refer to the wellfield concept plans.

For budgetary purposes assume the following for the wellfield sizing:

a. Bishop Elementary School – 60 wells, 6 circuits of 10 wells each isolated in old boiler room
b. Brackett Elementary School – 70 wells, 7 circuits of 10 wells each isolated in old boiler room
c. Dallin Elementary School – 80 wells, 8 circuits of 10 wells each isolated in old boiler room
d. Hardy Elementary School – 70 wells, 7 circuits of 10 wells each isolated in old boiler room
e. Peirce Elementary School – 60 wells, 6 circuits of 10 wells each isolated in old boiler room
a. Ottoson Middle School – 196 wells, 14 circuits of 14 wells each isolated in old boiler room

The geothermal wellfield pumping system, shall consist of two variable flow pumps (one operational – one 100% standby) for pumping the water to all heat pumps throughout the building via a closed loop piping system.

The pumps shall be located in a Mechanical Room and circulate water throughout the building to the individual heat pumps. Manual air vents shall be required at each pipe riser. A complete closed loop chemical treatment system shall be required.

For budgetary purposes assume the following for the pumps and piping mains:

b. Bishop Elementary School – 425 gpm @ 70 ft, 15 hp with 6" pipe mains
c. Brackett Elementary School – 500 gpm @ 70 ft, 15 hp with 6" pipe mains
d. Dallin Elementary School – 570 gpm @ 70 ft, 20 hp with 6" pipe mains
e. Hardy Elementary School – 500 gpm @ 70 ft, 15 hp with 6" pipe mains
f. Peirce Elementary School – 425 gpm @ 70 ft, 15 hp with 6" pipe mains
a. Ottoson Middle School – Two systems each at 625 gpm @ 70 ft, 25 hp with 6" mains

All geothermal piping mains interior of the building shall be Schedule 40 steel with grooved joints and fittings and/or copper piping as an alternative. Heat pump run outs shall be copper. The wellfield piping and building piping will be purged to remove dirt, debris, and air. The system will include side stream filtration, air elimination equipment, isolation zone/valves, central chemical treatment and fill, and a purge pump.

With typical geothermal supply water temperatures operating higher than the space due point, the geothermal piping will generally not be insulated however, include insulation of the mains from the mechanical room through tunnels, crawlspaces, etc., and any piping concealed above ceilings. Manual startup of the system shall be initiated, and the heat pumps shall be operated as required to prevent below dew point distribution water temperatures until steady state operating temperatures are achieved and maintained.

Unitary Geothermal Heat Pumps

Each heat pump will be a high efficiency, two-stage compressor heat pump unit with an ECM fan motor. Each heat pump unit will utilize refrigerant R-410A and will have an ozone depleting potential (ODP) of 0.05 or less. Most of the units will be floor mounted (vertical or horizontal) and installed in distributed mechanical room spaces located throughout the building unless noted otherwise. Refer to the HVAC zoning concept plans.

All heat pump units shall have fully ducted supply and return sheet metal ductwork. All supply air ductwork shall be insulated with 2.2" thick, ¾ pcf duct wrap with vapor barrier (installed R-value R>6). Return air ductwork will not be insulated. Each heat pump unit will include a duct-mounted pre-filter rack. The pre-filters shall be 24"x24" (4" deep) Astropleat MERV 11. Each heat pump shall include integral disconnect. Condensate for each unit will be disposed of through and floor drain, open receptacle, or condensate pump into the sanitary system. Each zone will have a thermostat (adjustable).

Heat pump units shall have two-stage scroll compressors, UV lamps and ECM variable speed fan motors. In general, to reduce quantity of units and associated maintenance, the schools will be zoned with two similar function classrooms on one heat pump still with individual control via motorized variable volume dampers. The gymnasium, cafeteria, kitchen, art classroom and media center systems will utilize unit-mounted non-ozone (UL 2998 zero-ozone certified) generating bipolar ionization to provide odor control and reduce OA demand in the variable occupancy spaces such as the gymnasium, café, and media center.

For budgetary purposes assume the following for the heat pumps:

- 1 ton unit – 400 cfm @ 12x12 SA/RA; 3 gpm with ¾" pipe
- 2-ton unit – 800 cfm @ 14x14 SA/RA; 6 gpm with 1" pipe
- 3-ton unit – 1,200 cfm @ 16x16 SA/RA; 9 gpm with 1-1/4" pipe
- 4-ton unit – 1,600 cfm @ 18x18 SA/RA; 12 gpm with 1-1/2" pipe
- 5-ton unit – 2,000 cfm @ 20x20 SA/RA; 15 gpm with 1-1/2" pipe
- 6-ton unit – 2,400 cfm @ 22x22 SA/RA; 18 gpm with 1-1/2" pipe
- 8-ton unit – 3,200 cfm @ 24x24 SA/RA; 24 gpm with 2" pipe
- 15-ton unit – 6,000 cfm @ 36x24 SA/RA; 45 gpm with 2-1/2" pipe

24/7 Cooling Areas, such as Elevator Equipment and MDF rooms, shall be provided with console style heat pump units where noted. An inline pump (B&G PL-55) connected to the condenser loop shall be provided for each unit and shall operate when the main loop pumps are off.

Small electrical rooms and IDF rooms shall be ventilated with plenum air by transfer air fans. Electric unit heaters shall be provided at the major points of entry. Assume 10 locations at 3 kW each.

Ventilation Systems

The outside air system for the buildings shall be de-coupled with one outside air unit except for Ottoson Middle School. The dedicated outside air handling units will be modular type (indoor or outdoor depending on the site) and include supply/exhaust plenum fans and utilize double wall construction. The unit shall be variable volume energy recovery type units utilizing building exhaust and general exhaust air to precondition the outside air through desiccant energy recovery wheels.

The air handling equipment shall be Trane, Carrier, Johnson Controls, Daikin, or approved equal, modular air handing units. The outside air unit will generally consist of one (1) dedicated air handling unit sized as noted below with the following sections/components: exhaust air tunnel will be a filter inlet filter/rack, energy recovery device, and two plenum type, exhaust air fans. The outside air tunnel will include an inlet filter, energy recovery device, access, hot / chilled water coil (2-pipe) with UV lamp, access, two plenum type supply air fans. Each fan will be controlled by a VFD for varying airflow conditions. The exhaust fan is sized at 20% reduction in capacity (thus maintaining building pressurization). The supply air distribution system will supply outside air to VAV terminal units (approx. quantity as noted) for distribution of outside air to each zone.

For budgetary purposes assume the following for the ventilation systems:

a. Ottoson Middle School – 48,000 cfm & 110 VAV terminals
   - Area A: 10,000 cfm
   - Area B: 9,000 cfm
   - Area C: 9,000 cfm
   - Area D: 16,000 cfm
   - Area E: 4,000 cfm

b. Bishop Elementary School – 12,500 cfm & 50 VAV terminals
c. Brackett Elementary School – 14,000 cfm & 49 VAV terminals
d. Dallin Elementary School – 14,000 cfm & 46 VAV terminals
e. Hardy Elementary School – 12,500 cfm & 51 VAV terminals
f. Peirce Elementary School – 11,500 cfm & 41 VAV terminals

In general, outside air shall be provided directly to the spaces with toilet/bathroom/janitors' closet, etc. exhaust being fully ducted and as well as general exhaust from all other spaces. In some cases where noted, the ventilation air shall be provided directly to return-side of the heat pumps and distributed via the heat pump ductwork systems. All conditioned outside air ductwork and building exhaust air ductwork will not be insulated – this applies to positive pressure outside air ductwork and negative pressure exhaust air ductwork. All un-conditioned air ducts shall be insulated with 3" thick, ¾ pcf duct wrap with vapor barrier – this applies to negative pressure outside air ductwork and positive pressure exhaust air ductwork.

Ventilation Systems

For demand control ventilation, classrooms and other appropriate spaces will also include CO2 and occupancy sensors. The thermostat (and associated sensors), CO2 and occupancy sensors are to interface to the building automation system. The CO2 and occupancy sensor inputs will be utilized to control the space ventilation terminal unit and space temperature set points.

To control outside air, a CO2 monitoring will be provided to take advantage of building diversity. Each variable occupied area will contain a CO2 sensor. The VAV terminal will modulate in accordance with the CO2 measurements. The VAV terminal will also be interlocked with new room occupancy sensor. The ventilation rate will be modulated based on occupied and vacant spaces conditions. Where a single terminal serves multiple spaces, the terminal shall control to the highest-demand space.

To further condition and dehumidify the outside air, the system will be provided with a water to water, reverse cycle, heat pump, chiller unit (size as noted below) located in the mechanical room. The heat pump chiller will provide hot or chilled water as required to condition the outside air (2-pipe system) at each unit via a closed loop piping system. The heat pump chiller is designed with two independent refrigeration circuits. The 2-pipe system will changeover from heating to cooling and vice versa based on outside air temperature. A separate hydronic pumping system will circulate water to the dedicated outside air handling unit. The 2-pipe loop will consist of copper piping and contain approximately 40% propylene glycol with chemical treatment and rust inhibitors. The 2-pipe loop will be insulated with glass fiber insulation.

For budgetary purposes assume the following for the water-to-waer systems:

a. Ottoson Middle School – 115 tons, 345 gpm, 6” mains, four 30-ton modular units – Waterfurnace NXW360
b. Bishop Elementary School – 30 tons, 90 gpm, 3” mains, one 30-ton modular unit – Waterfurnace NXW360
c. Brackett Elementary School – 36 tons, 108 gpm, 3” mains, two 18-ton modular unit – Waterfurnace NXW210
d. Dallin Elementary School – 40 tons, 120 gpm, 3” mains, two 20-ton modular unit – Waterfurnace NXW240
e. Hardy Elementary School – 36 tons, 108 gpm, 3” mains, two 18-ton modular unit – Waterfurnace NXW210
f. Peirce Elementary School – 30 tons, 90 gpm, 3” mains, one 30-ton modular unit – Waterfurnace NXW360

Air Distribution

All ductwork shall be galvanized steel constructed to SMACNA’s standards. All ductwork joints shall have a sealer applied as dictated by system duct pressure. Ductwork upstream of VAV boxes shall be medium pressure/velocity flat oval type with round runouts to boxes. All medium pressure ductwork shall be pressure tested. Ductwork downstream of the VAV boxes shall be low velocity, rectangular type. All HVAC air distribution systems shall be balanced to AABC standards.

In general, supply air diffusers shall be aluminum construction with a panel face and round neck (Titus OMNI-AA). Linear slot diffusers shall be used along the perimeter wall. Return and exhaust air grilles to be aluminum construction with a ½” egg-grate face mounted in a 24” x 24” lay-in ceiling panel (Titus 50F).

Temperature Control

A web-based BAC-Net DDC controls system shall be provided for the entire building and associated systems. The controls system will also include a JACE panel to communicate (wired/wireless) over the web-based area network. The BAS shall also interface with the building lighting, exterior lighting, and switch gear / electric metering. BTUH metering shall be provided for the central geothermal system. The system shall be ASHRAE 135 BACnet compliant using BTL listed components.

Kitchen Concept Narrative

Kitchen Appliances

Within each school kitchen, there are a handful of gas-fired appliances that would need to be removed and replaced by electric counterparts. At the time of design, it should be considered if all equipment will still be utilized with the centralized food prep model. At the time of design, the load of the new equipment should be evaluated to understand if a new breaker panel from the switchgear will be required.

Current gas-fired equipment to be removed and replaced with electric equivalents:

a. Ottoson Middle School – (1) four burner range, (1) double convection oven, (1) single convention oven
b. Bishop Elementary School – (1) two burner range, (1) tilting skillet, (1) fryer assembly, (1) double convection oven
c. Brackett Elementary School – (1) two burner range, (1) tilting skillet, (1) fryer assembly, (1) double convection oven
d. Dallin Elementary School – (1) two burner range, (1) tilting skillet, (1) 2-compartment steamer, (1) double convection oven
e. Hardy Elementary School – (1) two burner range, (1) tilting skillet, (1) double convection oven
f. Peirce Elementary School – (1) two burner range, (1) tilting skillet, (1) 2-compartment steamer, (1) double convection oven

Domestic Water Heating

OPTION 1: Domestic hot water will be produced from an air-source, compressorized heat pump unit (Nyle C250A) located in the main mechanical room. Hot water shall be stored in two 200-gallon insulated storage tanks. Cold, hot, and recirculating water piping will be routed throughout the school. All recirculation pumps shall have redundant pumps. The 110°F water shall be mixed utilizing a thermostatic mixing valve. All hand washing sinks & showers will be provided with a dedicated ASPE mixing valve to achieve the required temperatures to avoid scalding.

OPTION 2: Domestic hot water will be produced from a geothermal heat pump unit (Multistack HS354X2) located in the main mechanical room will provide the domestic hot water heating. Hot water shall be stored in two 200-gallon insulated storage tanks. Cold, hot, and recirculating water piping will be routed throughout the school. All recirculation pumps shall have redundant pumps. The 110°F water shall be mixed utilizing a thermostatic mixing valve. All hand washing sinks & showers will be provided with a dedicated ASPE mixing valve to achieve the required temperatures to avoid scalding.

Kitchen Hood & Makeup Air

The kitchen hood design utilizes a Type I hood with dedicated exhaust fan with variable speed controls. Makeup air will be provided through the main DOAS with a VAV terminal.

Freezer / Coolers

As the need for freezer / cooler replacements occur in the future, the district should consider using geothermal water-cooled units if the geothermal system selection option is chosen. The water-cooled condensers are more efficient than traditional air-cooled units. An inline pump (B&G PL-55) connected to the condenser loop shall be provided for each unit and shall operate when the main loop pumps are off. If the air-source VRF option is chosen, the air-cooled units should be placed in the main mechanical room with the air-cooled water heaters.

Electrical Concept Narrative

Electrical Service & Power Distributions

The buildings have the following existing electrical service sizes and capacities:

a. Ottoson Middle School – 4,000 amp; 208-3-phase
b. Bishop Elementary School – 1,200 amp; 208-3-phase
c. Brackett Elementary School – 1,200 amp; 480-3-phase
d. Dallin Elementary School – 1,200 amp; 480-3-phase
e. Hardy Elementary School – 1,200 amp; 208-3-phase
f. Peirce Elementary School – 1,200 amp; 480-3-phase

For HVAC system Option 1 (VRF), the following electrical service and power distribution scope is required:

a. Ottoson Middle School – No change required
b. Bishop Elementary School – New service required: 2,000 amp; 208-3 including switchgear and distribution
c. Brackett Elementary School – No change required
d. Dallin Elementary School – No change required
e. Hardy Elementary School – New service required: 2,000 amp; 208-3 including switchgear and distribution
f. Peirce Elementary School – No change required

For HVAC system Option 2 (Geothermal), the following electrical service and power distribution scope is required:

a. Ottoson Middle School – No change required
b. Bishop Elementary School – New service required: 1,800 amp; 208-3 including switchgear and distribution
c. Brackett Elementary School – No change required
d. Dallin Elementary School – No change required
e. Hardy Elementary School – New service required: 1,800 amp; 208-3 including switchgear and distribution
f. Peirce Elementary School – No change required

Interval load data with a temporary meter would ultimately be needed to confirm replacements and NEC compliance.

Interior Lighting

	Has LED Lighting?	
	Interior	Exterior
Ottoson Middle	Partial (gym, corridors)	All (2015)
Bishop Elementary	All	All (2015)
Brackett Elementary	Partial (corridors)	All (2015)
Dallin Elementary	Partial (gym)	All (2015)
Hardy Elementary	All	All (2015)
Peirce Elementary	All	All (2015)

Lighting retrofit to LED varies across the schools as follows:

Include the following scope of replacements and rework as follows:

a. Ottoson Middle School – 154,400 SF → include 120,000 SF of lighting scope
b. Bishop Elementary School – 51,370 SF → include 10,000 SF of lighting scope
c. Brackett Elementary School – 57,670 SF → include 46,000 SF of lighting scope
d. Dallin Elementary School – 68,580 SF → include 60,000 SF of lighting scope
e. Hardy Elementary School – 60,510 SF → include 12,000 SF of lighting scope
f. Peirce Elementary School – 48,500 SF → include 10,000 SF of lighting scope

Exterior Lighting

Existing exterior lighting has been converted to LED. No scope is required.

Building Envelope & General Construction Concept Narrative

Walls

The walls visually appear to be in good conditions at all facilities. We do not see the need to improvements related to the electrification scope of work.

Windows

The windows visually appear to be in good conditions at all facilities. We do not see the need to improvements related to the electrification scope of work. While windows were not investigated in detail during the site visit, when replacement is needed consider high performance thermally broken double-pane low e-glazing systems.

Roof

The roofs visually appear to be in good conditions at all facilities. We do not see the need to improvements related to the electrification scope of work. While roofs were not investigated in detail during the site visit, roof insulation should be replaced and increased to at least R-35 average insulating value when roof replacements are required.

a. Ottoson Middle School – 24 years old → consider replacement after 2028
b. Bishop Elementary School – 20 years old → consider replacement after 2032
c. Brackett Elementary School – 22 years old → consider replacement after 2030
d. Dallin Elementary School – 17 years old → consider replacement after 2035
e. Hardy Elementary School – 21 years old → consider replacement after 2031
f. Peirce Elementary School – 20 years old → consider replacement after 2032

Infiltration

To reduce air infiltration, some simple, low-cost measures should be implemented. All Exterior doors shall be weather sealed. Sealants and coatings should be repaired or reapplied across the entirety of the schools to improve air tightness and protect existing exteriors. Below are examples from the school site walks where air could easily infiltrate through exterior doors.

Infiltration at Bishop Elementary School

Infiltration at Hardy Elementary School

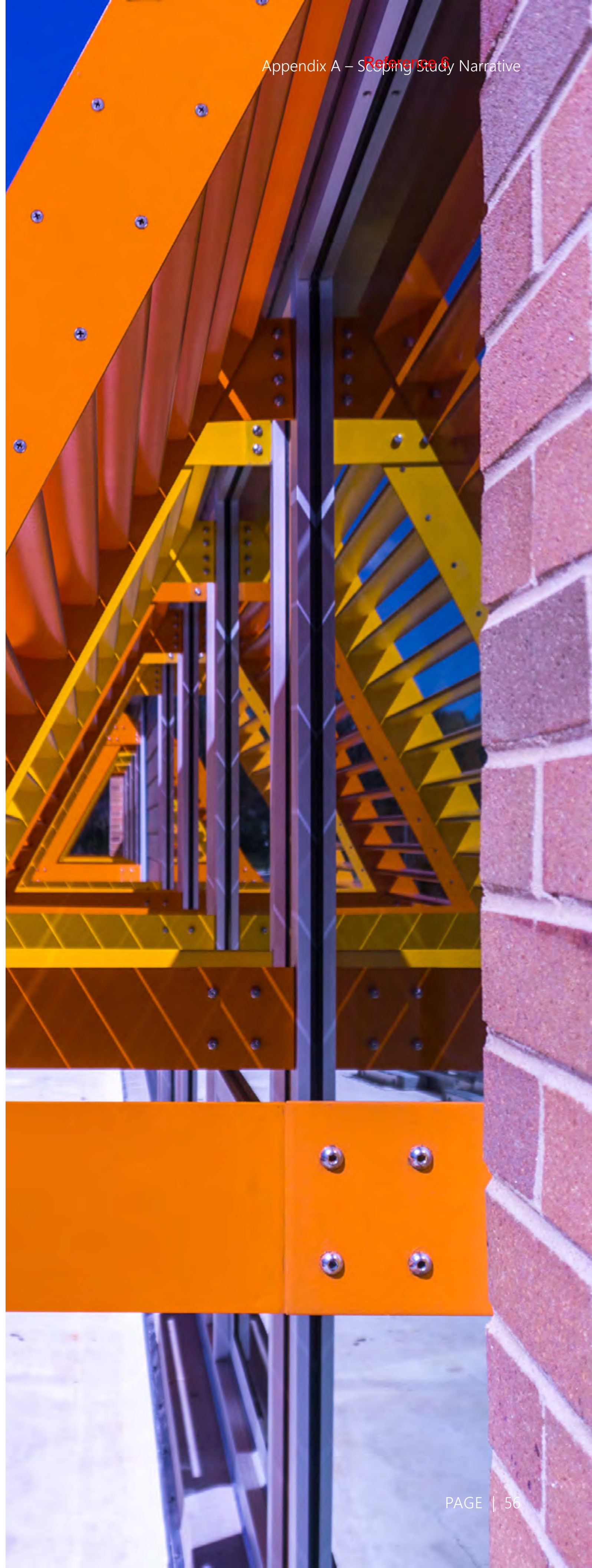
Ceilings

To implement the proposed HVAC system (both options) installation, assumptions have been made in terms of acoustic ceiling systems. For the purposes of the scope and budget development, include the following amount of ceiling replacement at each facility. The replacement shall include high quality, commercial grade 2x2 and/or 2x4 acoustical ceiling panels and corresponding t-bar grid.

a. Ottoson Middle School – 154,400 SF → include 120,000 SF of ceiling scope
b. Bishop Elementary School – 51,370 SF → include 10,000 SF of ceiling scope
c. Brackett Elementary School – 57,670 SF → include 46,000 SF of ceiling scope
d. Dallin Elementary School – 68,580 SF → include 60,000 SF of ceiling scope
e. Hardy Elementary School – 60,510 SF → include 12,000 SF of ceiling scope
f. Peirce Elementary School – 48,500 SF → include 10,000 SF of ceiling scope

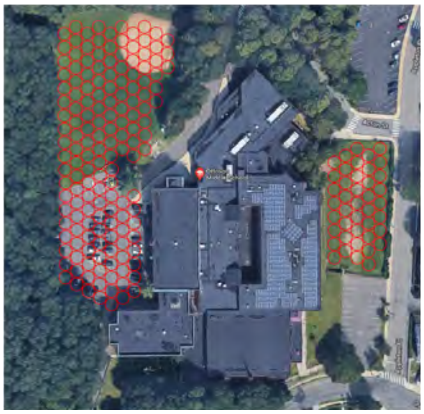
HVAC Equipment Rooms, Duct Chase & Structural Support

Depending on the HVAC option selection, various HVAC equipment rooms, duct chases and structural support of the various new components will be required. Locations for new HVAC equipment rooms and duct chases are noted on the concept planning documents. Assumptions for structural support will be required for budgetary purposes.



Site Work

In order to implement the proposed HVAC system (geothermal option), a certain amount of site work will be required. This shall include excavation and backfilling to allow for the geothermal piping and vaults. Replacement and repair of sidewalks and parking lots will be required in some cases. Additionally, in grassy areas, seed and straw will be required to rehabilitate the areas. Refer to the partial site plan, on the following pages, for each school delineating the areas of disturbance.



Ottoson Middle

63 Action Street, Arlington, MA 02476

Geothermal wellfield test-fit

Two wellfields and two vault spaces would be needed. This allows for the fields to fit on site and for the various wings of the school to be served more directly. Fields would need to be reseeded and lot repaved.

Bishop Elementary

25 Columbia Road, Arlington, MA 02474

Geothermal wellfield test-fit

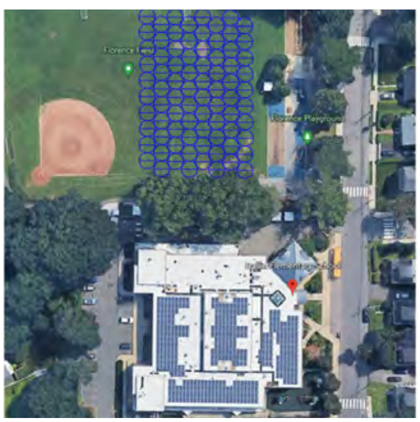
The adjacent park is owned by the city. City to coordinate between departments. Field would need to be reseeded.

Brackett Elementary

66 Eastern Ave, Arlington, MA 02476

Geothermal wellfield test-fit

The few trees would need to be removed, asphalt play surface would need to be removed/replaced, and baseball diamond reseeded.



Dallin Elementary

185 Florence Ave, Arlington, MA 02476

Geothermal wellfield test-fit

The adjacent park is owned by the city. City to coordinate between departments. Field would need to be reseeded.

Hardy Elementary

52 Lake Street, Arlington, MA 02474

Geothermal wellfield test-fit

Siting geothermal on asphalt due to the playground being newly installed with new surfaces, paving, landscaping, and equipment. Asphalt would need to be removed/replaced after geothermal installation.

Peirce Elementary

85 Park Ave, Arlington, MA 02474

Geothermal wellfield test-fit

Asphalt and play-place would need to be removed/replaced after geothermal installation.

Reference 7

Final Report

Pavement Management System Update

Arlington, Massachusetts

PREPARED FOR

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Introduction

The Town of Arlington hired Vanasse Hangen Brustlin, Inc. (VHB) in the fall of 2018 to perform a pavement condition evaluation of all town-maintained roadways as the basis for the implementation of a web-based pavement management system.

Starting with pavement inventory data previously developed in 2005 and updated in 2011, VHB performed visual inspections on 96.5 miles of town-maintained roadway. A pavement management system creates a benchmark of current pavement conditions throughout the Town, to assist in determining paving budget needs, and prioritizing pavement maintenance and rehabilitation. The comprehensive database is mapped using Geographic Information Systems (GIS) software to facilitate presentation and planning.

The following chapters present the process and findings of the roadway pavement study.

2

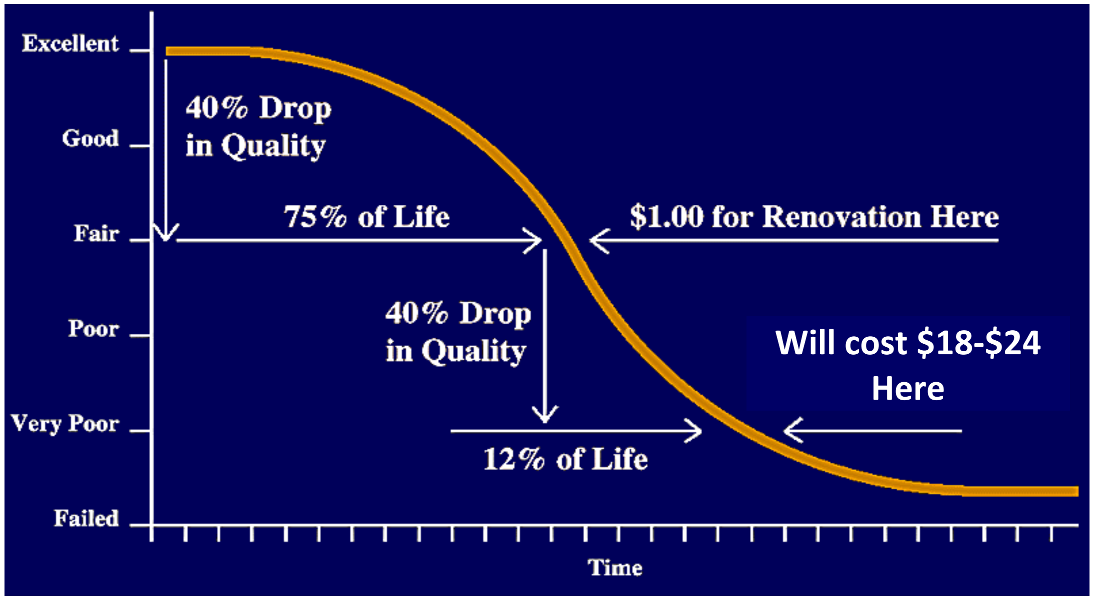
Pavement Management Process

Pavement management is the practice of planning for pavement repairs and maintenance with the goal of maximizing the value and life of a pavement network.

To accomplish this, a community needs to have several repair techniques in its arsenal and the knowledge of when to apply each of these. This is where pavement management comes into play. With a comprehensive database of road conditions, pavement management software can predict when to perform various repairs on a road network. Of course, engineering judgment is required to finalize any road program, as no software model can take every variable involved in making a repair decision into account. The software system is a great springboard to help a community start planning its road program each year and is an excellent method of storing the repair data.

A key fundamental in pavement management is the value of preservation treatments, which are the application of low-cost preventive measures to a road in fair condition, before it deteriorates to a condition that requires a much more expensive rehabilitation, as presented by the following graphic.

Figure 1 Typical Pavement Deterioration Curve



The Pavement Inventory and Condition Evaluation

Developing the pavement inventory includes the following three steps.

1. **Defining Pavement Management Segments:** Each road contains one or more pavement management sections. A pavement management section defines the limits of previous construction or maintenance activities within each road. Segments are defined by having the same width, typical distresses, one-way status, functional class, etc. The goal is to set up homogenous areas of pavement to aid in assigning the appropriate treatment.

2. **Surface Distress Assessment:** For each pavement management segment, the pavement surface was evaluated using the RoadManager distress evaluation method in which the roadway surface is evaluated for the presence of 9 categories of pavement distress. Each observed distress is recorded and evaluated for severity and extent. The distress categories are:

   - potholes
   - alligator cracking
   - distortion
   - rutting
   - block cracking
   - transverse or longitudinal cracking
   - bleeding or polished aggregate
   - surface wear or raveling
   - corrugations, shoving, and slippage

3. **Calculate PCI:** A weighted formula is used to convert the observed pavement distress data into a Pavement Condition Index (PCI) for each pavement segment. A PCI of 100

indicates a road surface in perfect condition. A PCI of 0 would represent a near impassible roadway.

Treatment Bands

In summarizing the condition of the pavement network, it is useful to categorize recommended repairs into 5 main categories.

Table 1 Treatment Band Descriptions

Treatment Band	PCI[1]	Description
Do Nothing	93-100	Excellent condition – in need of no maintenance.
Routine Maintenance	81-92	Good condition – may need crack sealing or minor localized repair.
Preventive Maintenance	73-80	Fair condition – pavement surface may need surface sealing, full-depth patch and/or crack sealing.
Structural Improvement	56-72	Deficient condition – pavement surface structure in need of added strength for existing traffic. Typical repairs are overlay with or without milling.
Base Rehabilitation	0-55	Poor condition – in need of base improvement. Typical repairs are reclamation or full-depth reconstruction.

1 These are only general PCI ranges for reference purposes and represent only one pavement type. There are several fields considered by the strategy table when assigning repair types to each individual Road.

Preparing Budget Scenarios

Once the roadway conditions are inventoried and analyzed, and the repair strategies are defined, the impact of various spending programs on the roadway network is assessed. These studies can range from 1 to 20 years; however, for the purpose of this report 5-year studies are used. The purpose of the budget planning process is to determine the impact of various spending levels to find a funding level that will best meet Arlington’s needs. The budget analysis software uses pavement deterioration curves, unit costs, and the strategy tables developed in the repair strategy definition phase to assign each street a repair type and associated cost for each year of the study. The software also assigns each street a benefit value that is used to prioritize which streets the software will select for repair each year. It is important to understand that a pavement management system is a network-wide planning tool and is not intended to give definitive street-by-street repair data. Field verification and testing are recommended to confirm any street repair list generated.

Deterioration Curves

In order to properly plan for future repairs, the budget analysis feature of the pavement management system uses deterioration curves. The deterioration curves estimate the rate at which the pavement condition decreases over time. These pavement deterioration curves depict two major categories of functional classification - arterials and collectors in one curve and local roads in the other as well as a differentiation for pavement type. The following deterioration curve is for a local HMA roadway.

Strategy Table (Decision Tree)

The pavement management system uses a table of repair strategies to assign specific road repair types to individual roadway segments. The repair strategy table incorporates PCI ranges as well as functional class and pavement type to simulate decisions consistent with Arlington's repair practices and procedures.

Project Prioritization

The budget analysis software prioritizes needed system repairs based on the estimated "Benefit Value". The Benefit Value formula is calculated using variables representing traffic volume, repair service life, PCI, and unit repair costs for each pavement management section. The calculation for the Benefit Value is shown below. For each plan year, the software prepares a future roadway condition projection, exhausts the assigned budget, and then produces an annual list of roads included in the repair program. The system also allows the user to enter an inflation rate to account for estimated increases in future year construction costs. A 4% inflation rate was used for Arlington.

The Benefit Value prioritization process generally favors cost effective maintenance alternatives. Repair actions are typically delayed on those sections that require reconstruction or major rehabilitation because the benefits for dollars spent are generally lower than maintenance candidates. After the relatively good roads are "saved", improvements are directed towards the poorer arterial and collector roads, and then to the local roads in need of major rehabilitation.

The calculation of Benefit Value is as follows:

$$Benefit\ Value = \frac{ADT * Life\ of\ Repair}{PCI * Unit\ Cost\ of\ Repair}$$

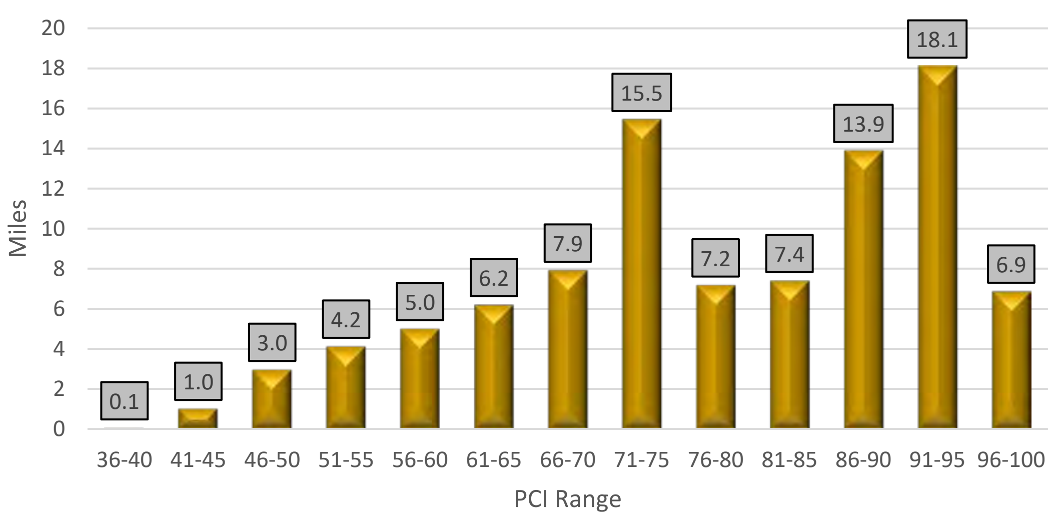
3

Pavement Conditions – Then and Now

The average Pavement Condition Index (PCI) for the Arlington road network is a 79. In the previous assessments done by VHB in 2005 and 2011, the average PCI was 81 and 76, respectively.

The following chart shows a detailed breakdown of the current condition of Arlington's roads by summing the number of miles of roadway into bands of 5 PCI points.

Figure 2 Current PCI Distribution

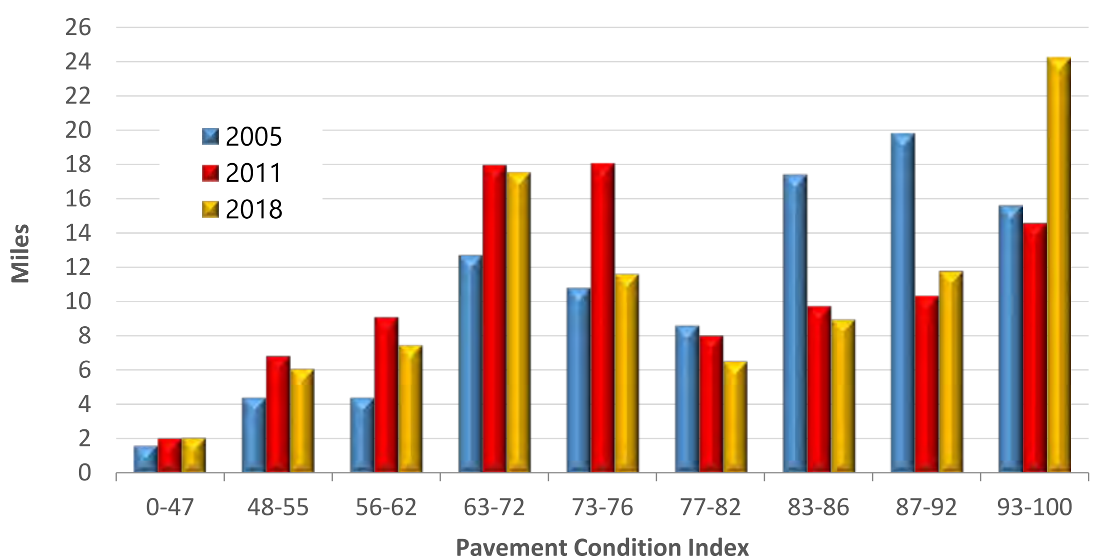


Historic Comparison

The average town-wide PCI was an 81 in 2005. It decreased by 5 points to a 76 in 2011 and has improved to a 79 in the most recent study. In addition to funding level changes over those spans, there have also been changes to the pavement maintenance and rehabilitation strategies employed by the Town. For example, the Town previously had an extensive chipseal (oil and stone surface treatment) program that was used to effectively maintain local roads. This program was suspended for a period which may have led to the decrease in average conditions. In recent years, the Town has reinvigorated its preventive maintenance program with the use of ultra-thin bonded wearing courses (UTBWC) and rubberized chipseals. UTBWC's are an effective treatment used on roads in fair condition that preserves the surface and achieves the look and rideability of a hot mix asphalt surface at a lower cost. Rubber chipseal a very flexible surface treatment that can improve the surface of a wide range of roadway conditions. It can "buy time" on roads in very poor condition as well as preserve roads in fair condition. Use of these cost-effective measures can have a significant effect on the overall road network.

A similar PCI distribution chart to the one on the previous page was presented as part of both the 2005 and 2011 pavement management studies. The following chart summarizes today's distribution of road miles in PCI bands using the same PCI ranges used in the previous studies.

Figure 3 Historic PCI Distribution Chart



The above chart shows that there has been a significant increase in the number of roads in excellent condition, very likely due to the use of the aforementioned surface treatments. The consistent use of a crack sealing program has also slowed the deterioration of roads in fair condition into the lower PCI ranges.

Backlog of Work

Using the Treatment Bands described in Chapter 2, the following table and charts summarize the backlog of pavement work in Arlington. The backlog represents the amount of work to bring every road in town to a near perfect condition. The backlog can be used as a benchmark to describe the current status of the pavement network.

Table 2 Summary of Miles and Dollars of Outstanding Work

Treatment Band	Miles	Dollar Backlog
Do Nothing	24.2	$0
Routine Maintenance	19.2	$365,000
Preventive Maintenance	19.7	$4,173,000
Structural Improvement	14.6	$5,979,000
Base Rehabilitation	18.8	$13,848,000
Totals	**96.5**	**$24,365,000**

The following two figures represent the above information graphically.

Figure 4 Backlog Distribution by Miles

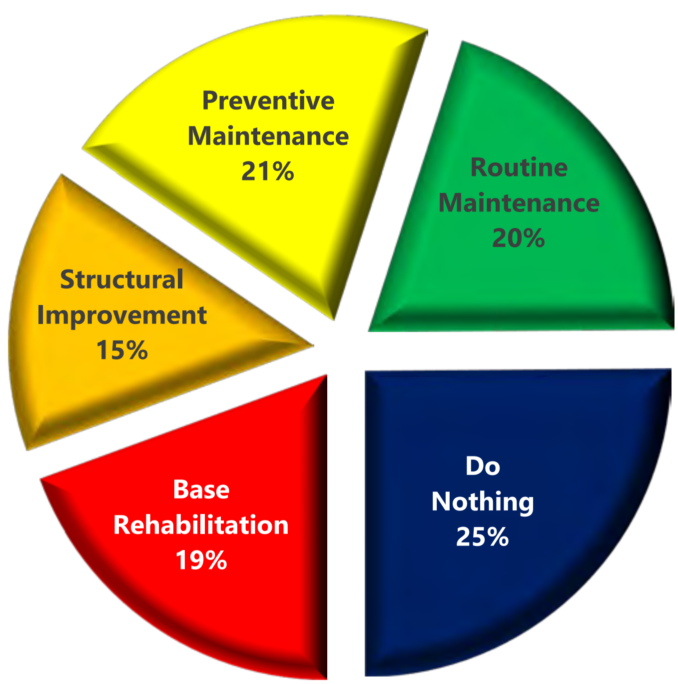
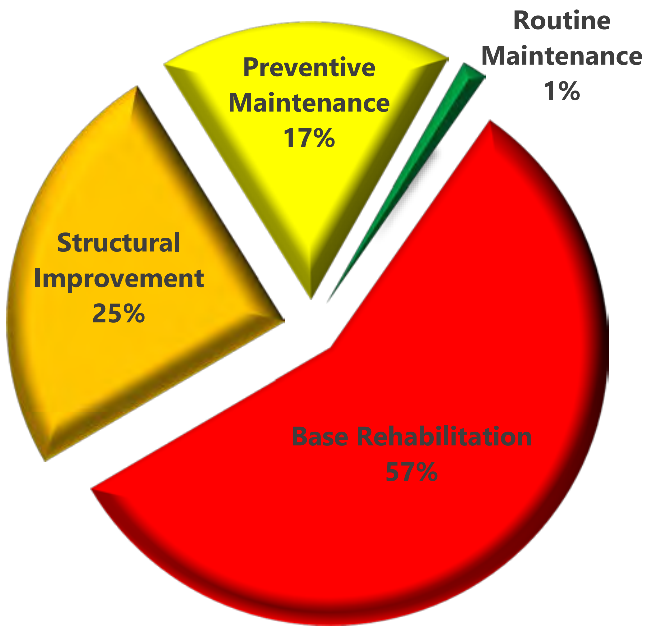


Figure 5 Backlog Distribution by Cost



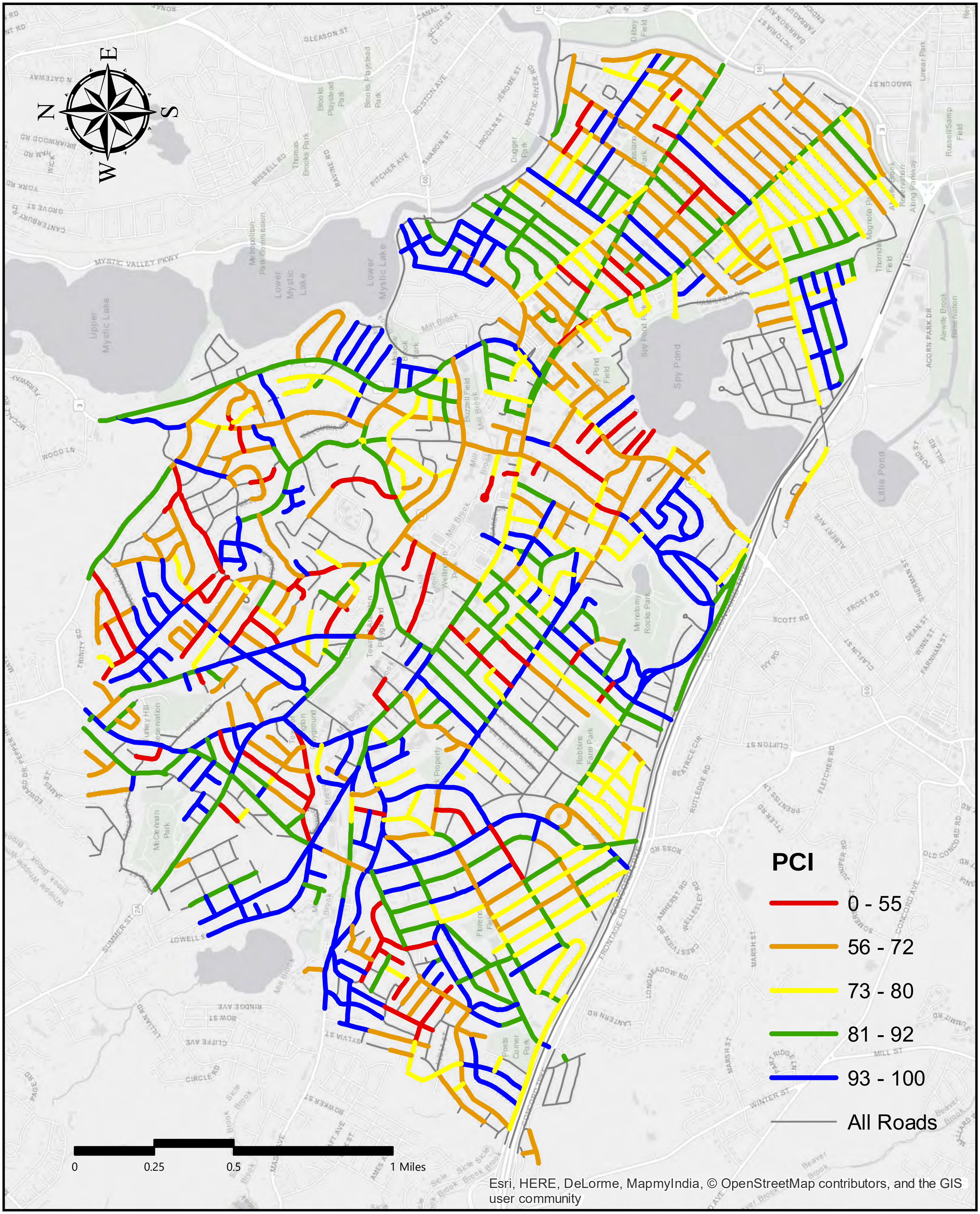
Figures 4 and 5 demonstrate that while less than 20% of the Town's roads need Base Rehabilitation, they account for 57% of the outstanding backlog of work. Base rehabilitation is the most expensive category of road repair. Also of note, is that 40% of the Town's miles could benefit from preservation treatments. It makes good fiscal sense to spend the funds to extend the lives of the large number of roads in need of maintenance.

Pavement Condition Map

The map on the following page shows Arlington roads colored by the 5 PCI ranges corresponding approximately to the 5 Treatment Bands. This map is a smaller scale representation of maps available to the Town through the pavement management system.

Reference 7

Figure 6: Pavement Condition Map



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4

Budget Analysis – Pavement

Arlington has a major investment in its 96.5 Town maintained road network. It is easy to forget that roadways are a community's single largest investment. Based on Arlington's unit cost for reconstruction, without considering signs, signals, curbing, or sidewalks, it would cost Arlington over $114,000,000 in today's dollars to reconstruct the existing Town maintained roadway network.

Funding Scenarios

Using pavement management software, VHB is able to predict the effects that various funding levels would have on the road network in terms of average PCI, and outstanding backlog of work. VHB analyzed the following three funding scenarios:

- $ 1,500,000/Year
- $ 2,000,000/Year
- $ 3,000,000/Year

The $1.5 Million funding level is based on approximately $780,000 of Chapter 90 state funding and $800,000 of local town funds, minus $80,000 in operational costs. The $2 Million and $3 Million amounts were determined using the software to achieve the results shown below.

Summary of Budget Results

The following graphs show the effects of the three annual funding levels analyzed on Arlington's road network over the next five years.

Figure 7 shows the budget level effect on the average network PCI.

Figure 7 PCI Projections

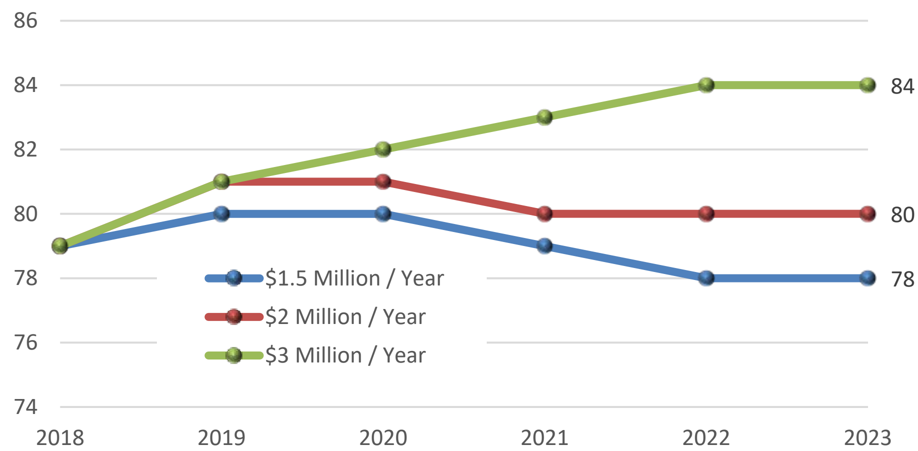
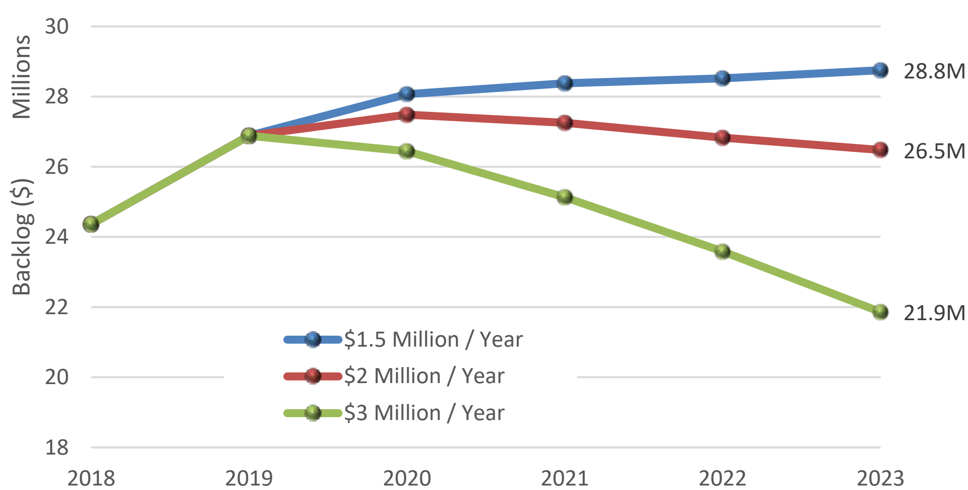


Figure 8 shows the budget level effect on the dollar backlog of work.

Figure 8 Backlog Projections



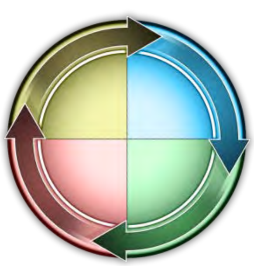
The scenario results indicate that while each of the funding levels may maintain conditions for a few years (due to catching up on preventive maintenance), the current funding level will not be adequate to maintain condition long term and address the backlog of expensive structural improvement and rehabilitative work. A funding level of $2M/year would be needed to maintain network conditions and stabilize the backlog of work, while a funding level of $3M/year would result in an aggressive increase in overall condition, and a decrease in the backlog of work.

5

Concluding Remarks

The Town of Arlington has a pavement management system based on updated road condition data collected in 2018. The Arlington pavement management system gives Town decision-makers a picture of existing roadway infrastructure conditions and a dollar estimate to improve streets in poor condition while protecting those pavements currently in good condition.

The Pavement Management System being implemented by the Town is a planning tool, with primary functions of determining the funding levels required to achieve Town wide condition goals, and to identify candidate road projects to achieve those goals. Any project list generated by the system needs to be reviewed by the Engineering Department staff and adjusted based on numerous factors, including coordination with utility work, and geographic issues.



Recommendations – Pavement Management

- Budget adequate funds to achieve pavement condition goals
- Make timely maintenance repairs
- Repair localized base problems before applying an overlay
- Address major rehabilitation needs as funding allows
- Develop multi-year road programs
- Coordinate with local utilities to perform upgrades and repairs in advance of projected construction projects

- Perform project level testing prior to major rehabilitation projects to ensure proper life of new pavement
- Provide for construction inspection at the plant and in the field to ensure quality material is provided and quality work is being performed
- Update database to reflect work that is done (maintains accuracy of system)
- Update pavement conditions at a minimum of every 4 years or 25% per year
- Track specific and overall conditions periodically
- Evaluate funding levels periodically
- Continue preventive maintenance program
- Continue to work with Utilities to fund lasting repairs to roads disturbed by trenching. Utility cuts have had a significant impact on the road network.

6

Appendices

Appendix A: Pavement Unit Costs

The following unit costs for pavement repair alternatives were used in the backlog summary tables within this report, as well as the Backlog Report in the following Appendix.

Note that the repairs listed below are representative of the levels of repair utilized by the Town. For example, Bonded Wearing Course is one type of surface treatment that is used to conservatively estimate the cost for that category of treatment.

Name	Cost/SY
Do Nothing	$0.00
Crackseal	$0.50
Crackseal & Patch	$2.00
Rubber Chip Seal	$7.00
Bonded Wearing Course	$13.00
Overlay	$18.00
BoxCut/Level/Overlay	$24.00
Mill & Overlay	$29.00
Reclaim and Pave 4"	$48.00
Reclaim and Pave 5.5"	$52.10

Reference 8

Report | May 2015
Submitted to **Town of Arlington- Department of Public Works**

Town of Arlington
Sidewalk, Ramp, Curb and Street Tree Evaluation

vhb

Table of Contents

1 Introduction

Introduction

The Town of Arlington retained Vanasse Hangen Brustlin, Inc. (VHB) in 2014 to develop an inventory of sidewalks, ramps, curbing and street tree issues on all Town Maintained Roads. VHB inventoried the location of these features and key information such as material, condition and compliance issues. The inventory was undertaken in order to develop a comprehensive pedestrian sidewalk, ramp, curb and tree database describing the locations and conditions to better understand Arlington's pedestrian accessibility infrastructure. This inventory will help the Town identify areas that may not meet the Americans with Disabilities Act (ADA) guidelines and help provide priorities on which features are interfering with pedestrian accessibility issues. The inventory was done using GPS enabled tablet PC's to accurately locate the features. Each feature was assessed and given a condition rating (Excellent Good, Fair, Poor). For the sidewalks, ramps and curbing material and specific ADA measurements were recorded. The following pages summarize the findings.

The map on the following page is an overview of the features inventoried.

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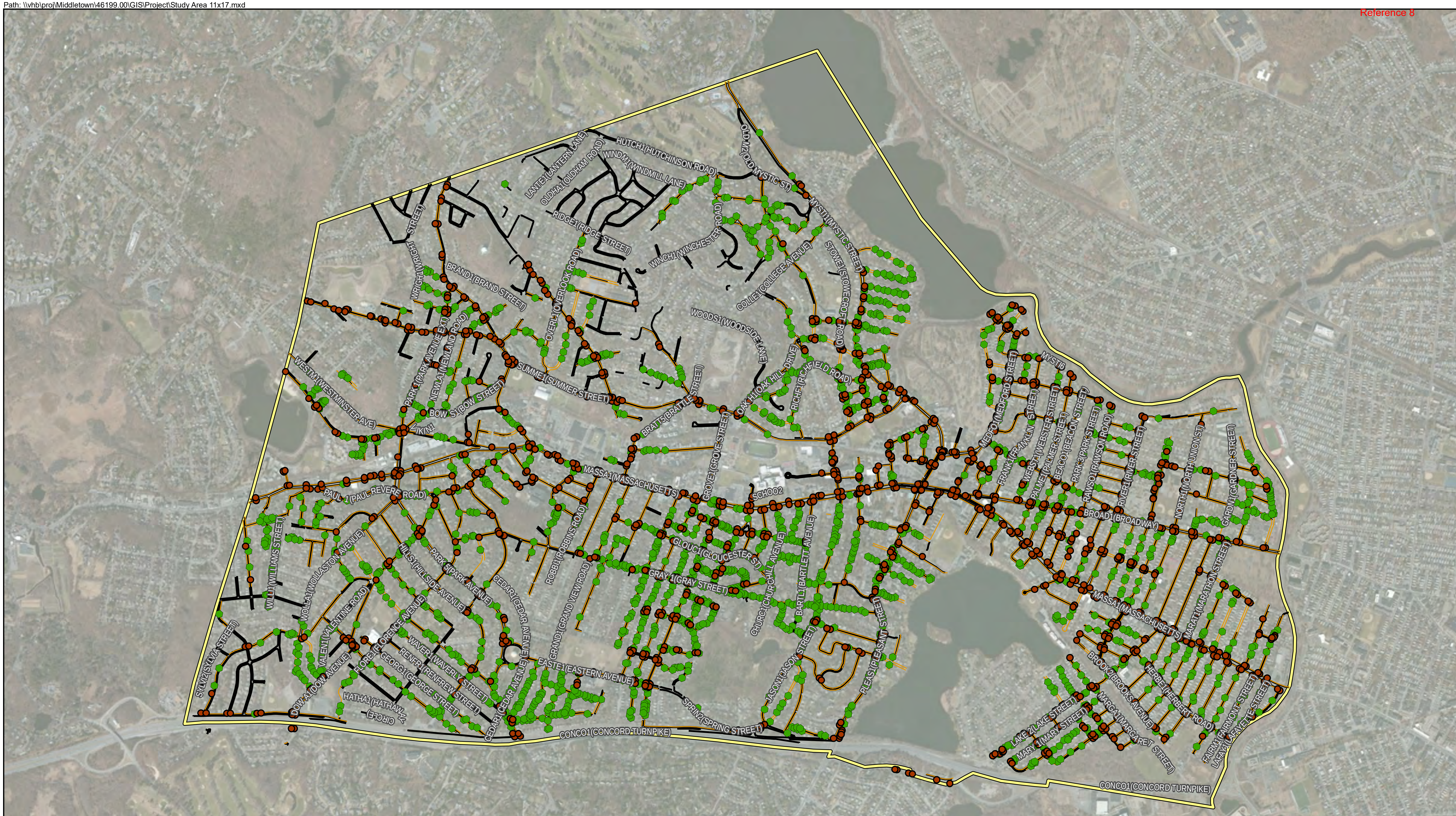
Reference 8



Legend

- Ramps
- Trees
- Sidewalks
- Curbs

Town of Arlington

Study Area

November 2014

Figure 1

0 750 1500 Feet

N

2

Sidewalks and Ramps

Sidewalks and Ramps

Using field tablet computers, Global Positioning System (GPS) receivers, and existing Geographic Information Systems (GIS) layers, VHB conducted a Town-wide pedestrian sidewalk and ramp inventory and assessment utilizing GIS integration to build a comprehensive database.

Approximately 131 miles of sidewalks were inventoried along with 1,552 pedestrian ramps throughout the Town of Arlington, including ramps that were classified as "missing" where existing crosswalk markings led to vertical curb face(s) with no curb cut to access sidewalk. It should be noted that that the Town has gaps within their sidewalk and ramp network. In addition to the existing features inventoried, there are also approximately 42 miles of missing sidewalks (gaps) and 653 missing ramps.

Sidewalks were evaluated for the following criteria:

Sidewalk Material
Material consisted of three main types

- Bituminous Concrete
- Portland Cement Concrete
- Brick

Sidewalk Distressed Area
Field crews inspected all sidewalks for damage areas included cracking, lips at curb and back of sidewalk, missing bricks, empty tree pits, lifting concrete sidewalk

panels, utility cuts, and tripping hazards. These distressed areas were measured and used to calculate a percentage repair area for each segment.

Sidewalk Width
Average width of the sidewalk segment. (Measured to the nearest half foot)

Sidewalk Slope
This measurement was based on a sidewalk cross-slope taken at a visually determined location where the slope appears to be the steepest, as a worst-case scenario within the segment.

Percent Non-Compliant
If a sidewalk had non-compliant (>2%) cross slope measurements. The percentage of sidewalk area exhibiting non-compliant cross slopes was estimated and recorded.

Sidewalk Condition
A sidewalk condition value was established to quickly categorize sidewalk conditions into a repair strategy schema. Sidewalks were graded by the following.

- Excellent (Like New Condition)
- Good (Light Wear)
- Fair (Considerable Wear, Cracking, or Distortion)
- Poor (Wear, Cracking or Distortion significantly impacts serviceability)

Ramps were evaluated for the following criteria:

Ramp Material
Material consisted of three main types

- Bituminous Concrete
- Portland Cement Concrete
- Brick

Ramp Condition
A ramp condition value was established to quickly categorize ramp conditions into a repair strategy schema. Ramps were graded by the following.

- Excellent (Like New Condition)
- Good (Light Wear)
- Fair (Considerable Wear, Cracking, or Distortion)
- Poor (Wear, Cracking or Distortion significantly impacts serviceability)

ADA Compliance
VHB inventoried the sidewalks and pedestrian ramps defined within the study area and followed the ADA "Tool Kit" which includes instructions and methodologies on how to survey sidewalks, curb and ramps to determine if they comply to ADA standards (for more information on the ADA Tool Kit please refer to this link http://www.ada.gov/pcatoolkit/chap6toolkit.htm). Upon completion of the

assessment, VHB analyzed the results (see below) and will provide the information to the Town in GIS format.

Title II of the ADA requires state and local governments to make pedestrian crossings accessible to people with disabilities by providing curb ramps. To allow people with disabilities to cross streets safely, state and local governments must provide curb ramps at pedestrian crossings and at public transportation stops where walkways intersect a curb. To comply with ADA requirements, the curb ramps provided must meet specific standards for width, slope, cross slope, placement, and other features. The Town of Arlington has 884 ramps that are not ADA compliant and an additional 653 ramps missing within their sidewalk network.

The following are the key characteristics of an accessible curb ramp according to the ADA Standards:

- The ramp run has the least running slope possible. (On a curb ramp, the running slope is the slope in the direction of pedestrian travel on the ramp run.)
- For curb ramps constructed after January 26, 1992 (post-ADA), the slope must be 8.33 percent (1:12) or less.
- For curb ramps constructed before January 26, 1992 (pre-ADA), including those that have since been altered, the running slope must generally be 8.33 percent (1:12) or less. However, ramp runs with greater slopes are allowed for pre-ADA curb ramps in the two following instances where space limitations prohibit the use of a slope of 8.33 percent (1:12) or less:
  - The ramp run may have a running slope of up to 10 percent (1:10) if the rise is no more than six inches.
  - The ramp run may have a running slope of up to 12.5 percent (1:8) if the rise is no more than three inches.
- The cross slope of the ramp run itself may not exceed 2 percent (1:50). (On a curb ramp, the cross slope is the slope perpendicular to [across] the direction of pedestrian travel on the ramp run.)
- The ramp, or ramp run, must be at least 36 inches wide, not including the flared sides.
- The ramp run must have detectable warnings – i.e., dome-shaped bumps – that extend the full width and depth of the ramp.
- Transitions from the ramp to the walkway, gutter, and street must be flush (level) or have a less than ¼" lip and free of abrupt level changes.
- The gutter must have a slope of no more than 5 percent (1:20) toward the ramp.

Ramp Replacement "Alteration" Policy

Municipalities are required to make pedestrian facilities ADA compliant any time alterations are done to the facilities themselves or the adjacent roadways. The U.S. Department of Justice and U.S. Department of Transportation have defined roadway alternations to include roadway reconstruction, pavement overlays (with or without milling), open graded surface course, microsurfacing, cape seals, in place asphalt recycling, and thin lift overlays. Crack sealing, slurry seals, chip seals and fog seals, have been deemed maintenance, and not an alteration requiring ADA improvements.

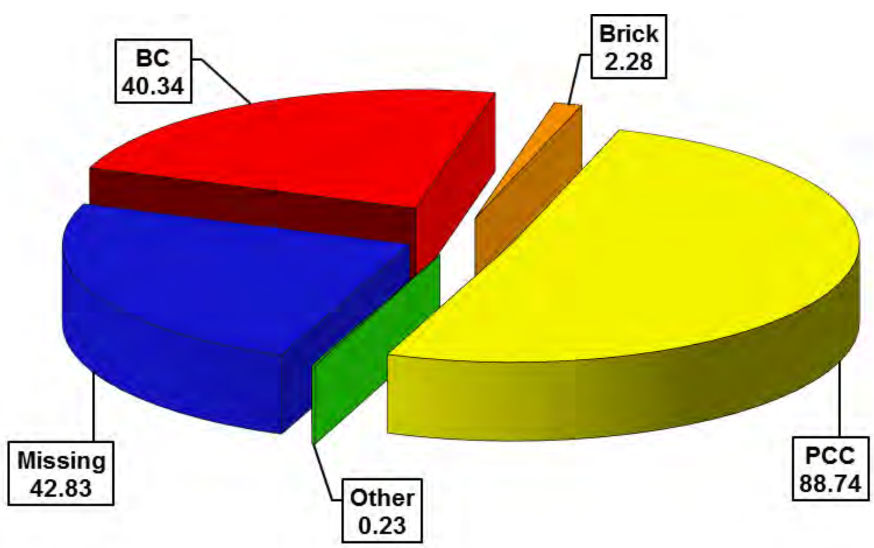
Sidewalks and Ramp Inventory Summaries

Sidewalk Inventory Summaries

Sidewalk Material Summary in Miles

The following table and chart summarize the mileage of Arlington sidewalk by material type.

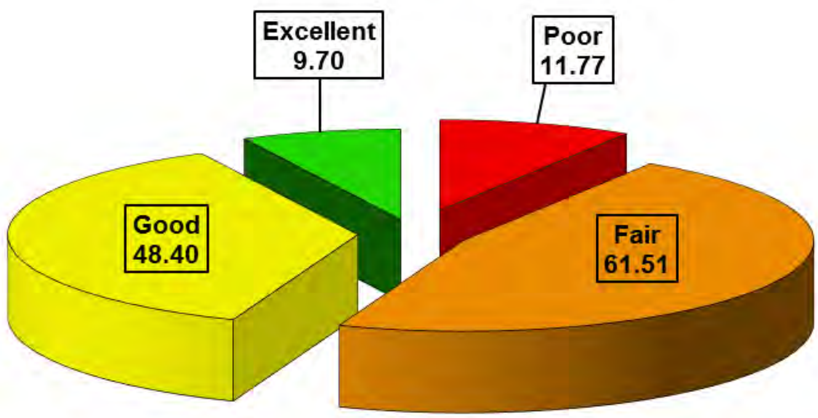
Sidewalk Material	Miles
Bituminous Concrete (BC)	40.34
Brick	2.28
Portland Cement Concrete (PCC)	88.74
Other Materials	0.23
No Sidewalks (Missing)	42.83



Sidewalk Condition Summary in Miles

The following table and chart summarize the mileage of Arlington sidewalk by condition.

Sidewalk Condition	Miles
Excellent	9.70
Good	48.40
Fair	61.51
Poor	11.77



Sidewalk Condition Index

In order to track changes in the overall condition of the Town's sidewalk network, every sidewalk was assigned a Sidewalk Condition Index (SCI) so that a network average could be calculated. The SCI was assigned based on the condition rating:

- Excellent = 100
- Good = 85
- Fair = 70
- Poor = 55

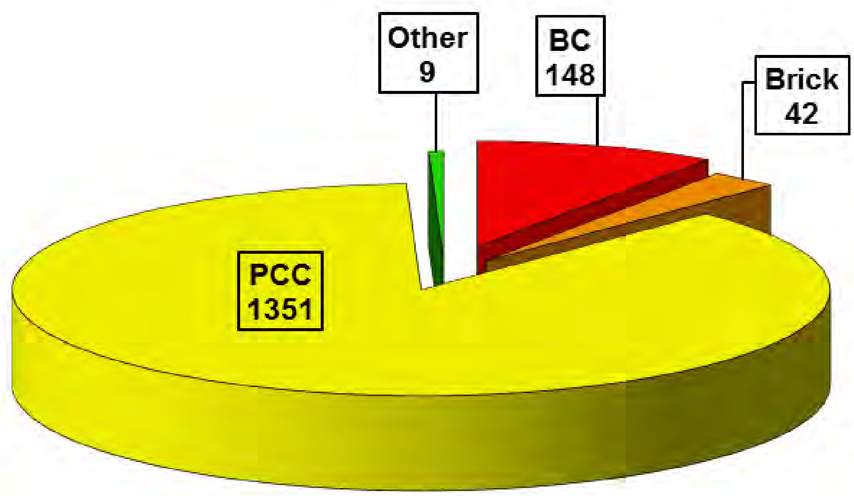
This rating system puts the sidewalks on a compatible scale to the Town's RoadManager Pavement management System. **The Town's average SCI weighted by length is a 76.7.**

Ramp Inventory Summaries

Ramp Material Summary

The following table and chart summarize the number of ramps by material type.

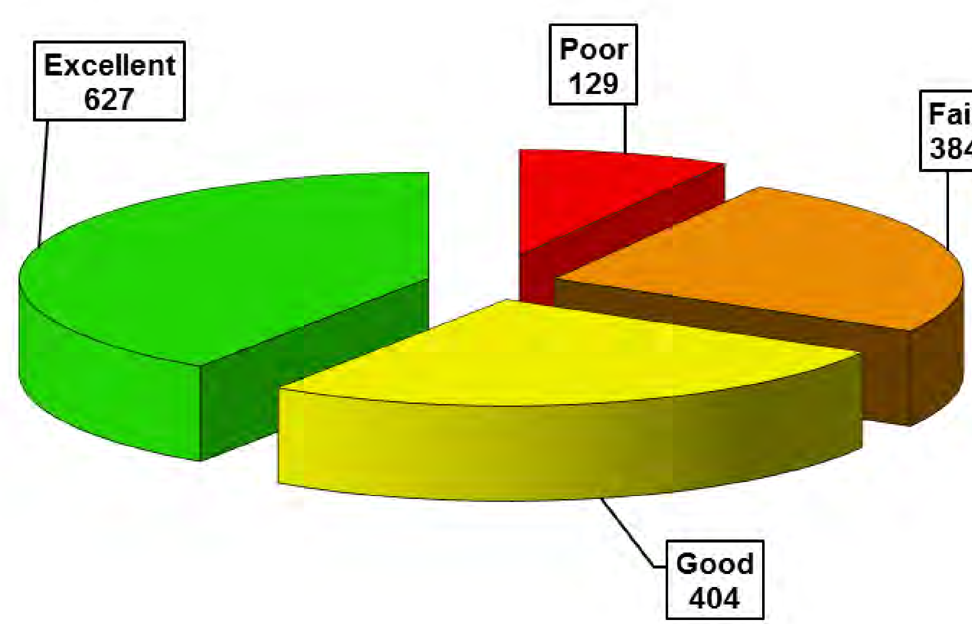
Ramp Material	Count
Bituminous Concrete (BC)	148
Brick	42
Portland Cement Concrete (PCC)	1351
Other Materials	9
Missing	653



Ramp Condition Summary

The following table and chart summarize the number of ramps by condition.

Ramp Condition	Count
Excellent	627
Good	404
Fair	384
Poor	129



Ramp Condition vs. Compliance

For purposes of this report, ramp condition relates directly to the condition and wear of the ramp materials, which will correlate to how smooth the ramp is, and to how long it may last in serviceable condition. Condition may not account for safety, alignment, and slope criteria. Detailed compliance data for each ramp has been provided to the town, and a summary of compliant ramps exists in the Cost section of this report.

Ramp Condition Examples

Excellent Condition Ramp – Concord Turnpike and Dow Avenue

Good Condition Ramp – Radcliff Road and Victoria Road

Ramp Condition Examples (cont.)

Fair Condition Ramp - Massachusetts Avenue and Robbins Road

Poor Condition Ramp – Tanager Street and Aberdeen Road

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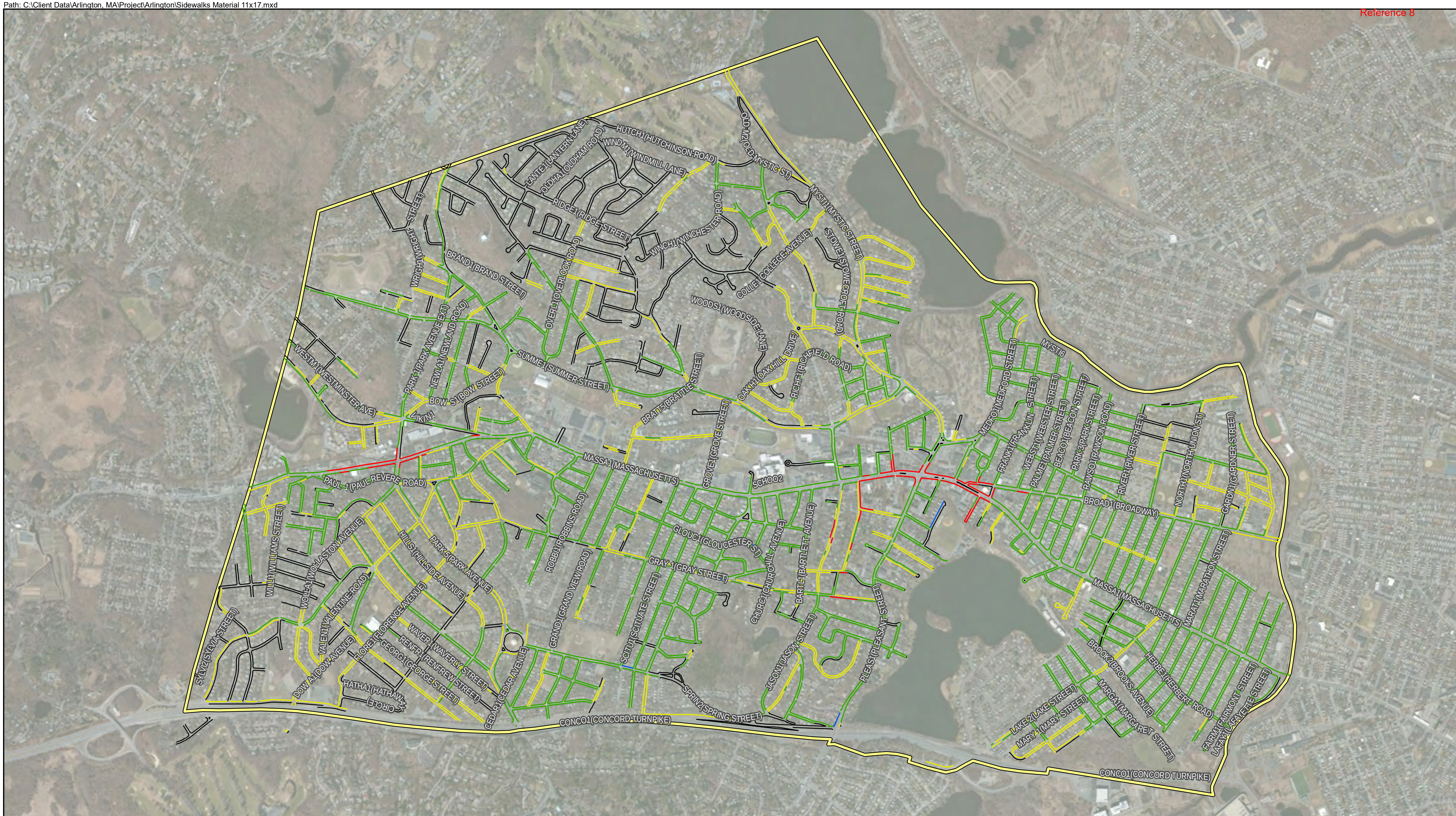

Legend

Material

Bitunimous Concrete

Portland Concrete Cement

Brick

Other

Missing/No Sidewalk

Town of Arlington

Sidewalk Materials

November 2014

Figure 2

0 750 1500 Feet

N

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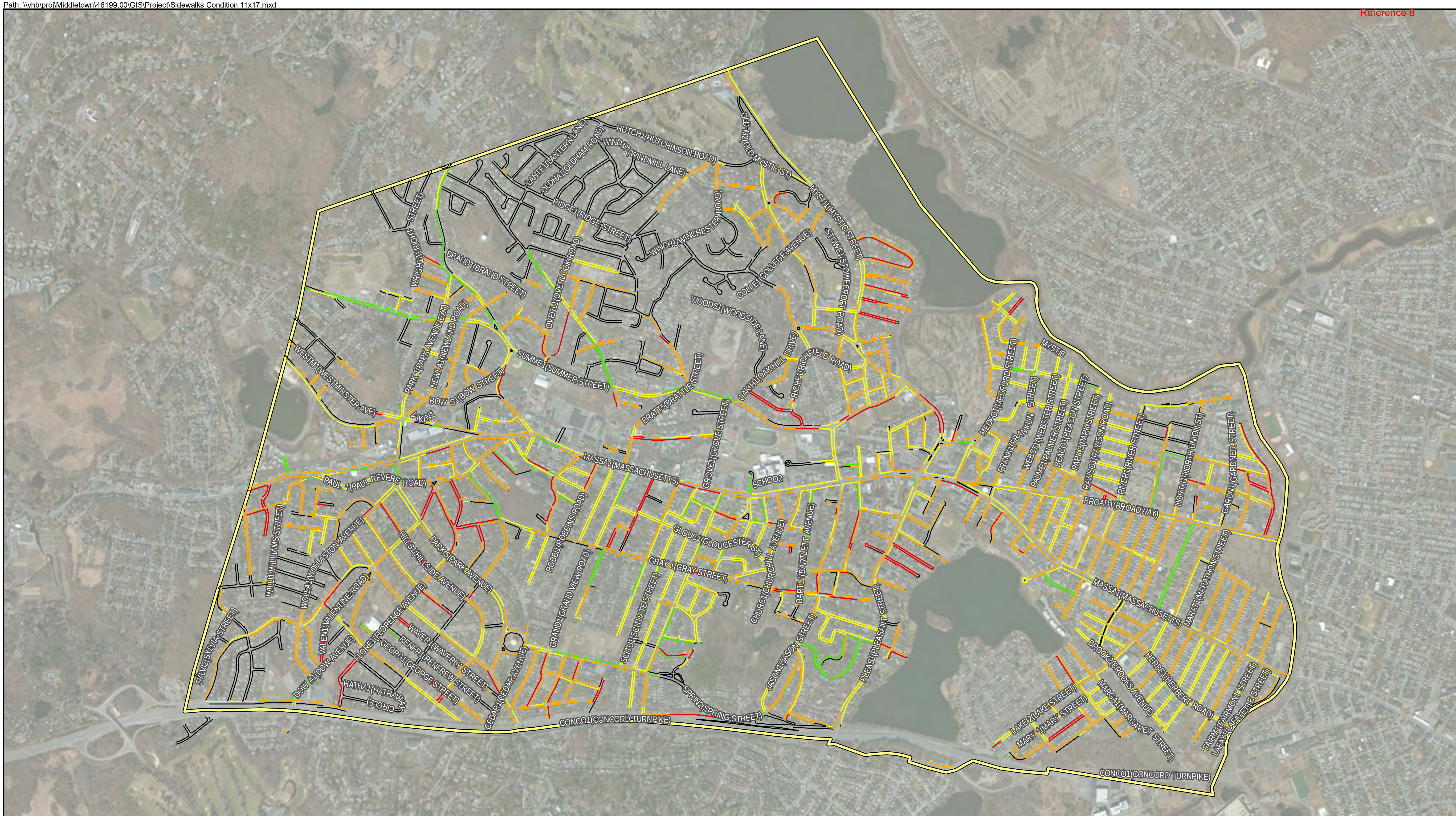

Legend

Sidewalk Condition

- Excellent
- Good
- Fair
- Poor
- Missing/No Sidewalk

Town of Arlington

Sidewalk Condition

November 2014

Figure 3

0 750 1500 Feet

N

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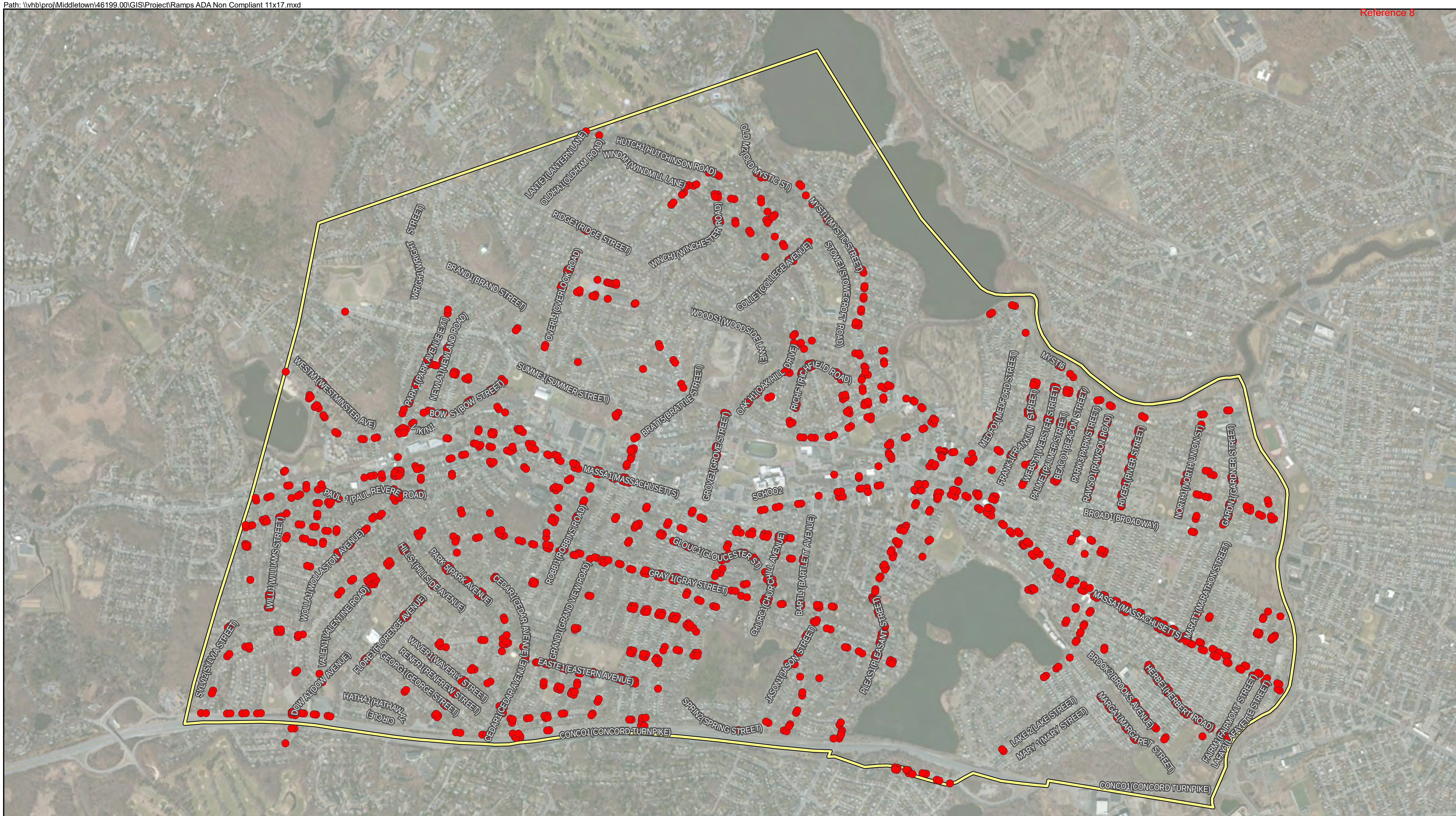


Legend

Ramps Not Meeting All Current ADA Criteria

Town of Arlington

Ramps Inventory

November 2014

Figure 4

0 750 1500 Feet

3

Curbing

Curbing

VHB inventoried the curbing along the streets in Arlington. Each street was checked to verify the existence of curbing. The curbing material, average reveal and condition was recorded. There were approximately149 miles of curbing inventoried. There are approximately 28 miles of roadways that do not have curbing.

The reveal for each curb segment was measured and an average reveal for that segment was recorded. The condition of the curbing was assessed using ratings of Excellent, Good, Fair and Poor.

Curb Material

Curbing consisted of five types

- Bituminous Concrete
- Granite
- Cape Cod Berm
- Portland Cement Concrete
- Sloped Granite

Curb Reveal

Average curb reveal along a given sidewalk segment was measured. Curb segments were broken out in the database on a street block-to-block basis.

Curb Condition

A curb condition values was established to quickly categorize curb conditions into a repair strategy schema. Curbs were graded by the following.

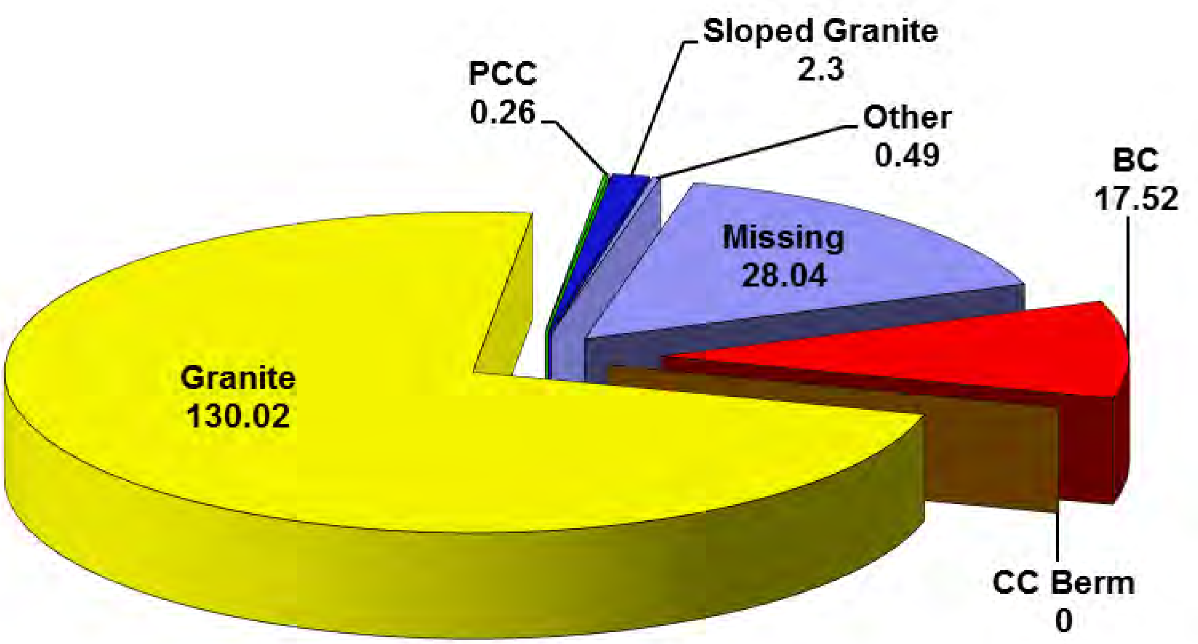
- Excellent (Like New)
- Good (Light Wear)
- Fair (Minor breaks, gaps, or uneven pieces)
- Poor (Significant breaks, gaps, or uneven pieces)

Curb Inventory Summaries

Curb Material Summary in Miles

The following table and chart summarize the mileage of curbing by material type.

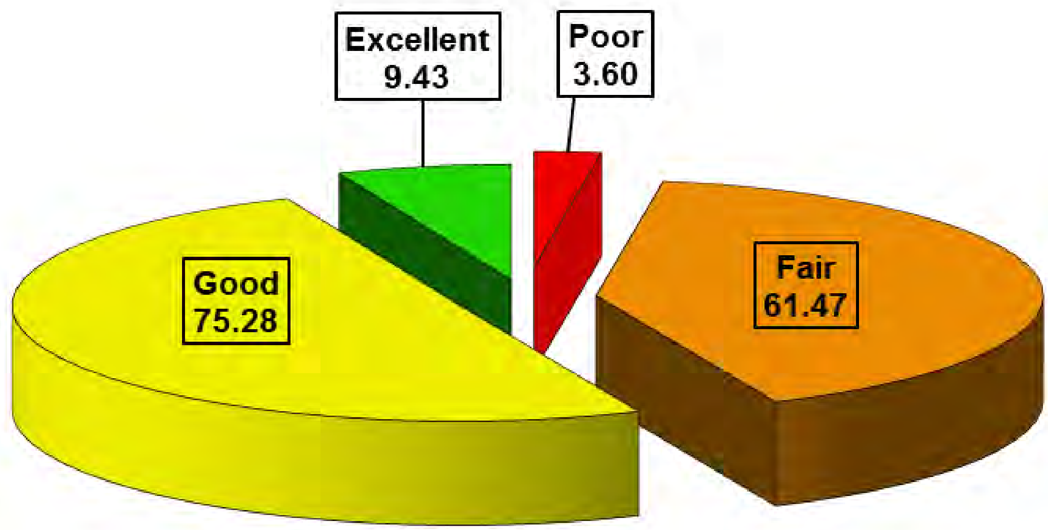
Curb Material	Miles
Bituminous Concrete (BC)	15.90
Cape Cod (CC) Berm	0
Granite	130.82
Portland Cement Concrete (PCC)	0.26
Sloped Granite	2.30
Other	0.49
None (Missing)	28.04



Curb Condition Summary in Miles

The following table and chart summarize the mileage of curbing by condition.

Curb Condition	Miles
Excellent	9.43
Good	75.28
Fair	61.47
Poor	3.60



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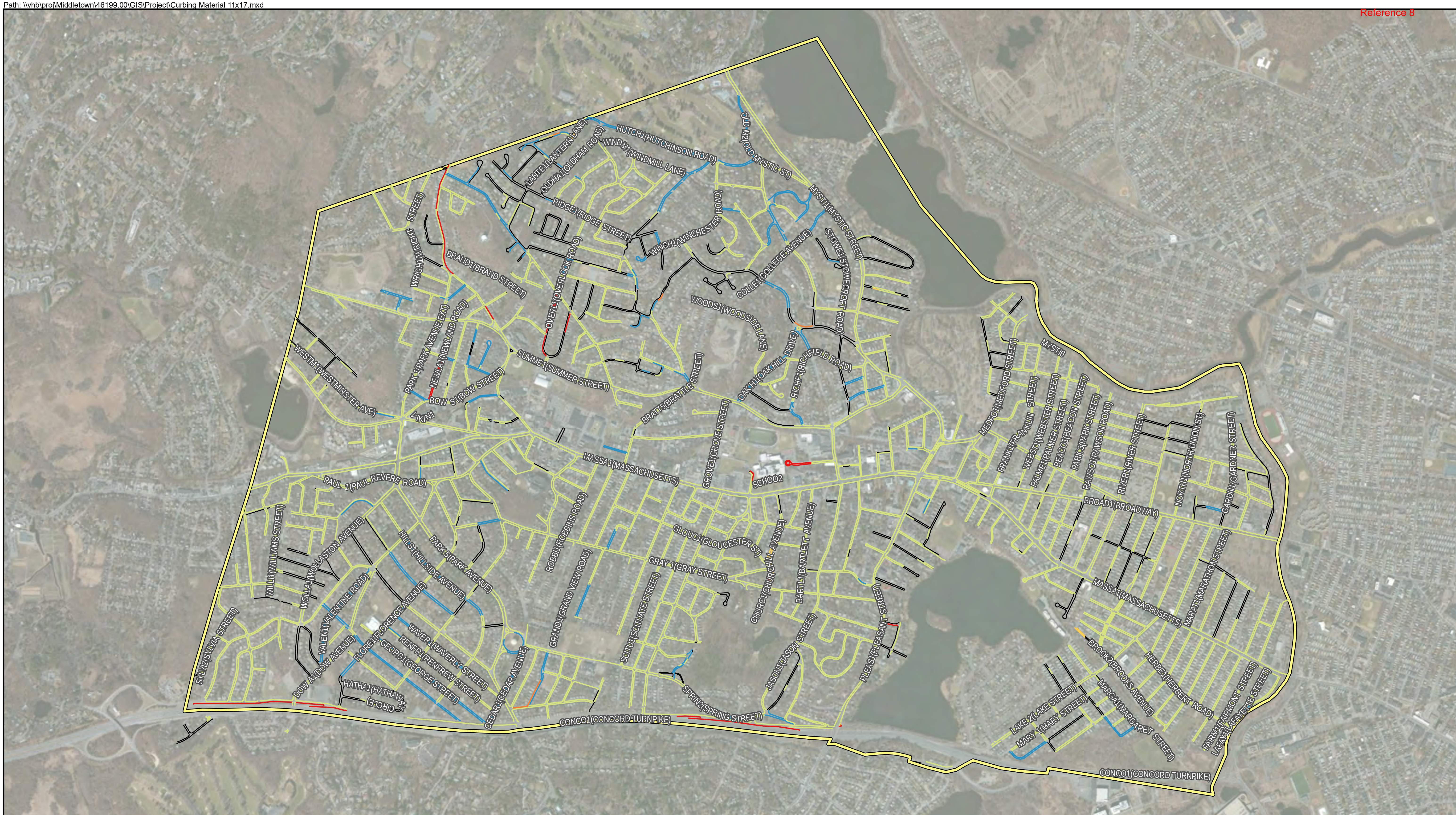

vhb

Legend

CMaterial

- Bituminous Concrete
- CC Berm
- Granite
- Other
- Portland Cement Concrete
- Sloped Granite
- No Curbing/Missing

Town of Arlington

Curb Material

November 2014

Figure 5

0 750 1500 Feet

N

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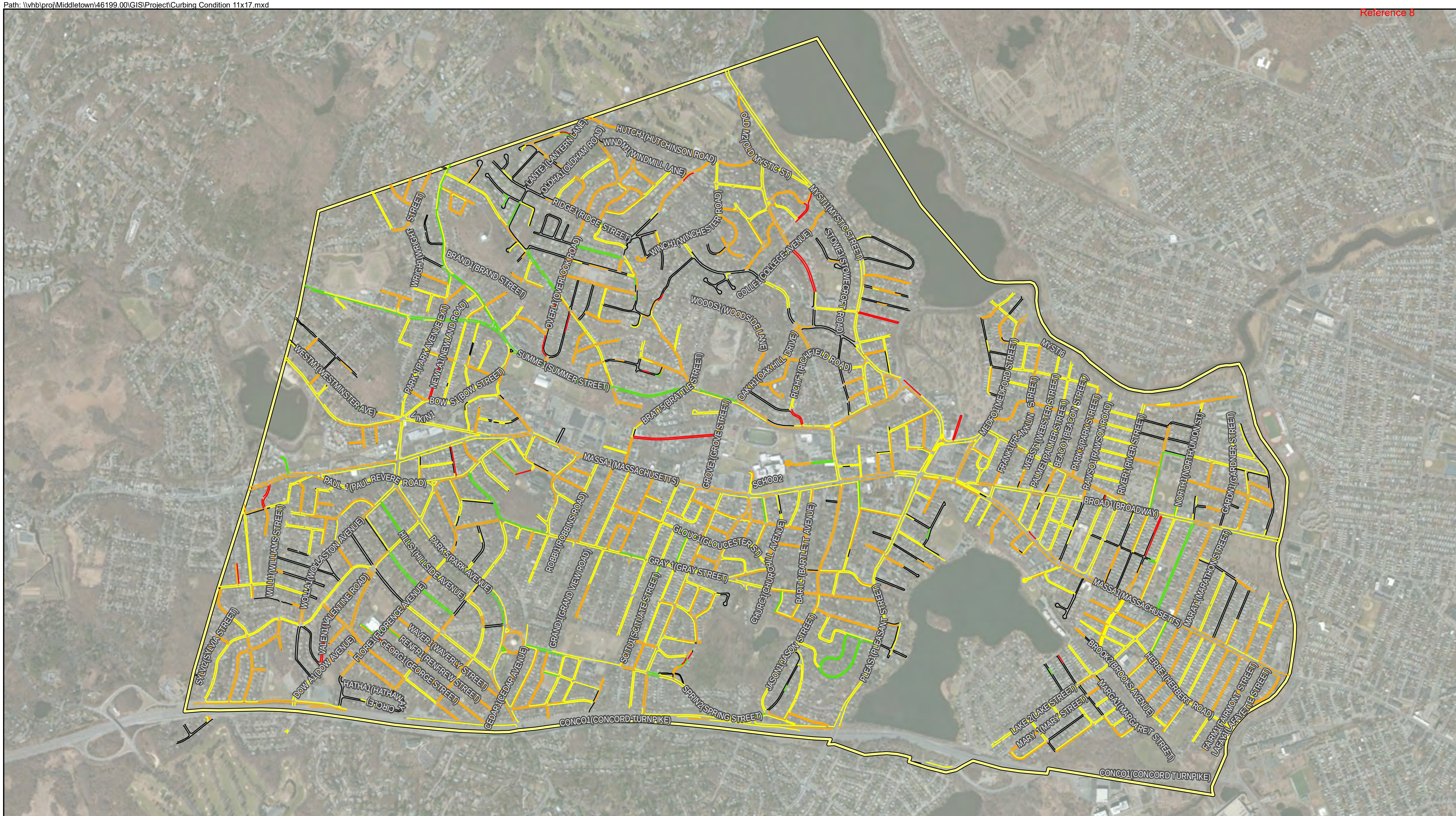


Legend

Curb Condition

- Excellent
- Good
- Fair
- Poor
- No Curbing/Missing

Town of Arlington

Curb Condition

November 2014

Figure 6

0 750 1500 Feet

N

4

Street Tree/Sidewalk Impacts

Trees

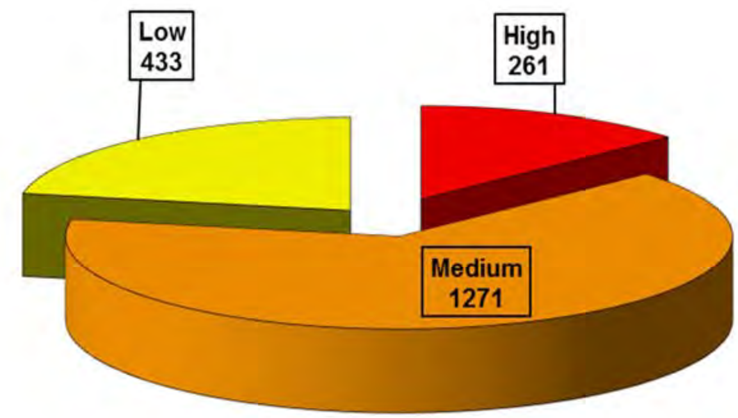
VHB inventoried the trees along the sidewalks within the town and assessed the severity of impact of each tree on the street, sidewalks and ramps. Almost 2,000 trees were assessed. Each tree was GPS located and the severity of its impact on the adjacent surfaces was rated as being high, medium or low. A high rating indicates the tree has had a major impact on the usability of the sidewalk A medium rating indicates the tree has moderate impact to the usability of the sidewalk, and a rating of low indicates there has been minimal impact or the situation has already been addressed.

Tree/Sidewalk Impact Summaries

Tree Impact Severity Summary

The following table and chart summarize the inventory of tree impacts by severity.

Impact	Count
Low	433
Medium	1271
High	261



Tree Impact Severity Samples

Tree Severity Low – Churchill Avenue

Tree Impact Severity Samples (cont.)

Tree Severity Medium – Quincy Street

Tree Severity High – Glenburn Road

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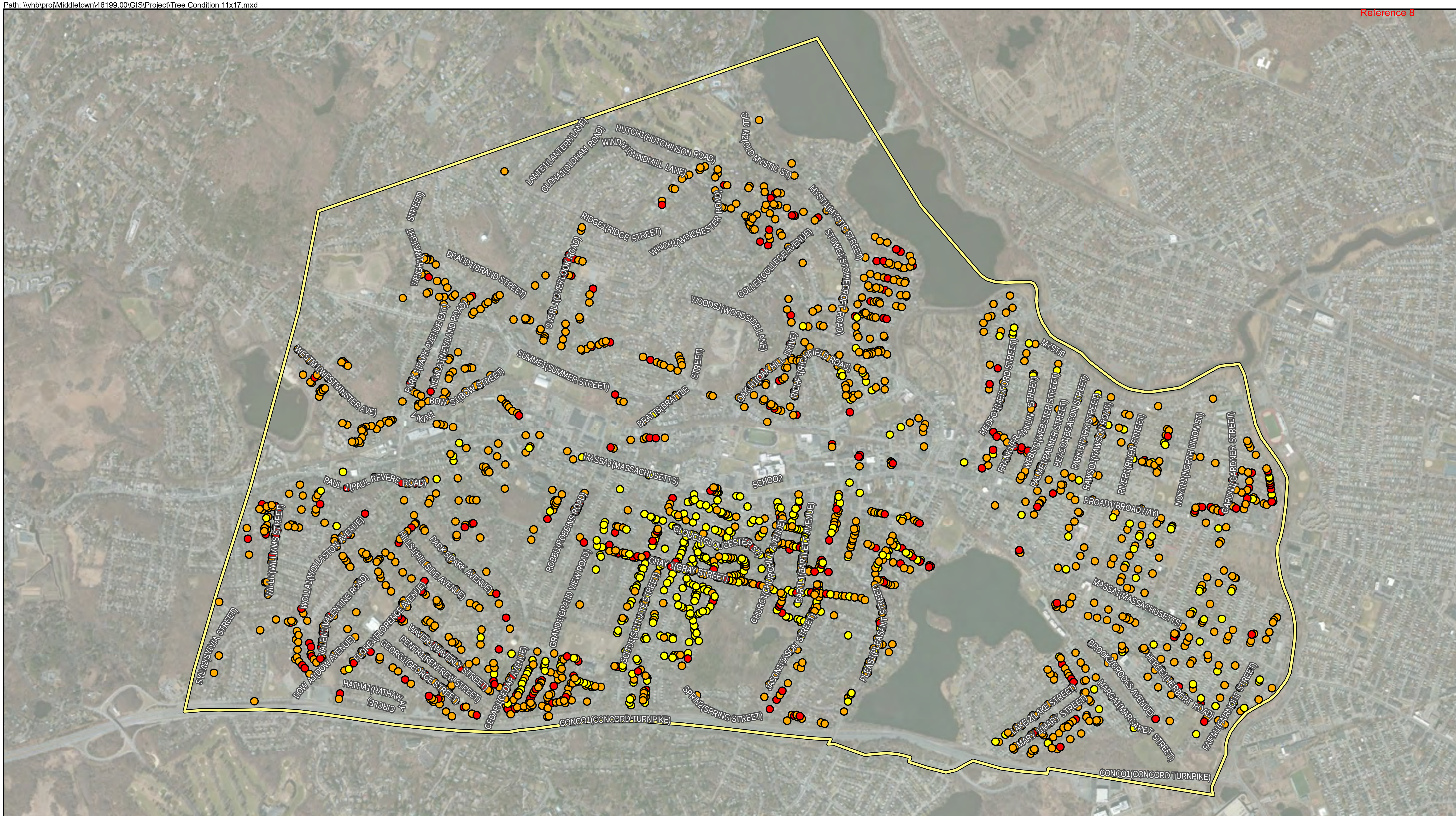
Reference 8



Legend

Tree Severity

- High
- Medium
- Low

Town of Arlington

Tree Severity Condition

November 2014

Figure 7

5
Costs

Sidewalk Repair Costs

Having established a detailed inventory for existing sidewalks, financial costs are needed for future budget planning. Consideration was given based on historical pedestrian sidewalk repair costs, material classification, and sidewalk damage area. Sidewalks that were identified as having a **Poor** condition, and 50% of **Fair** condition, were used to calculate backlog. Sidewalks identified Good or Excellent condition were considered not to need repair unless there was a tree identified as having a medium or high severity of impact. The following sidewalk budgetary reconstruction costs were used for analysis.

Sidewalk Material	Area (SY)	Unit Cost (SY)
Portland Cement Concrete	61,161	$57
Brick	4,040	$167
Bituminous Concrete	51,788	$37

Backlog is defined as the cost of repairing all sidewalks, partial panel replacement, and full replacement sidewalk reconstruction within one year bringing sidewalks that were classified as poor to excellent condition. Backlog is a “snapshot” or relative measure of outstanding repair work. The backlog not only represents how much repair is outstanding, but it also offers a basis for comparison for future and/or past year’s backlog(s) to determine if the Town is catching up, or falling behind. Backlog dollars represent the cost to repair sidewalks only. It does not include related repair costs for relocation and installation of utilities, lighting, signal apparatus, signs, or landscaping. As of December, 2014, Arlington backlog of sidewalk repair work totals **$6,077,324.**

Budget considerations for trees were based on historical costs, and material classification. Trees that were identified as having a medium and high impact to a sidewalk were used to calculate backlog. Sidewalks that are impacted by a tree, a 20'x5' long section of sidewalk was estimated to be replaced around the tree.

Sidewalk Material	Number of Impacts	Unit Cost (each)
Portland Cement Concrete	797	$411
Brick	8	$411
Bituminous Concrete	716	$411
*All tree/sidewalk repairs will be in bituminous concrete.		

As of December, 2014, sidewalk repair costs associated with tree impacts totals **$625,131.**

As of December, 2014, Arlington backlog of sidewalk repair work including sidewalks in Fair and Poor condition and trees impacting sidewalks costs a total of **$6,702,455.**

There are approximately 42.83 miles of missing sidewalks within the Town's sidewalk network. Assuming a new sidewalk is constructed at 5' wide and using Portland cement concrete material, it would cost the Town **$7,161,176.**

Ramp Repair Costs

Budget considerations for ramps were based on historical costs, and material classification. Ramps were categorized into two groups to calculate backlog. If the ramp was likely ADA compliant, it was considered do nothing, however; if the ramp did not meet current compliance criteria, it is expected to be reconstructed.

Ramp Material	Number of Ramps	Unit Cost (each)
Portland Cement Concrete	657	$4,500
Bituminous Concrete	142	$4,500
*All new ramp construction will be in Portland concrete cement.		

Backlog is defined as the cost of replacing all ramps within one year bringing ramps that were classified as not ADA complaint to meet ADA standards. Backlog is a "snapshot" or relative measure of outstanding repair work. Backlog dollars represent the cost to replace ramps only. It does not include related repair costs for relocation and installation of utilities, lighting, signal apparatus, signs, or landscaping.

As of December, 2014, Arlington backlog of ramp replacement totals $3,595,500.

Ramps that were identified as "missing" or gaps in the sidewalk ramp network account for a total of 653. Assuming all new sidewalk ramps will be constructed with Portland cement concrete material, it would cost the Town $2,938,500.

Curb Repair Costs

Budget considerations for curbs were based on historical costs, and material classification. Curbs that were identified as having a Poor condition were used to calculate backlog. Curbs identified Fair, Good and Excellent conditions were considered do nothing.

Curb Material	Length (Miles)	Unit Cost (lf)
Bituminous Concrete	0.95	$5
Granite	2.04	$35
Portland Cement Concrete	0.03	$35
Sloped Granite	0.48	$35
*Poor Portland Cement Curb will be replace by Granite		

Backlog is defined as the cost of replacing all curbs within one year bringing curbs that were classified as poor to excellent condition. Backlog is a "snapshot" or relative measure of outstanding repair work. Backlog dollars represent the cost to replace curbs only. It does not include related repair costs for relocation and installation of utilities, lighting, signal apparatus, signs, or landscaping.

As of December, 2014, Arlington backlog of curb repair work totals $496,320.

The Town has a total of 28.04 miles of curbing missing within their network. Assuming the Town uses Granite material if would cost $5,181,792 to install new curbing in all roadsides currently without curbing.

Cost Summary

The following table summarizes the backlog of sidewalk, ramp, and curbing work described in the previous sections.

Feature	Cost
Replace all Poor and 50% of Fair Sidewalks	$6,077,324
Repair Sidewalks Impacted by Trees	$625,131
Install Sidewalk on roadsides where none exists	$7,161,176
Replace Non-compliant Ramps	$3,595,500
Install "missing" Ramps	$2,938,500
Replace Poor Curbing	$496,320
Install Granite Curbing where none exists	$5,181,792

The costs in this table have not been totaled, as they are not considered to be a total backlog of needed work. The need for installation of new sidewalk and curbing should be evaluated on a case by case basis by the town.

6

Recommendations

Summary and Recommended Plan of Action

The overall pedestrian sidewalk network in the Town of Arlington is currently in fair to good condition. Using the reconstruction costs, it was calculated that the backlog for repairing sidewalks in Arlington totals to $6,077,324. For the Town to add the missing sidewalks (fill in the gaps) it would cost an additional $7,161,176.

The overall pedestrian ramp network in the Town of Arlington is also currently in fair condition. The data gathered from this study shows a "high-probability" that only 57% of Arlington's pedestrian ramps are in compliance with ADA standards. This study shows that future diligence with respect to ADA standards will be necessary to improve Town-wide ramp conditions. The backlog to reconstruct these ramps to compliance would cost Arlington $3,595,500. For the Town to fill the gaps for the missing pedestrian ramps, it would cost $2,938,000.

The overall curbing network in the Town of Arlington is currently in fair to good condition. Using the reconstruction costs, it was calculated that the backlog for repairing curbing that was in poor condition in Arlington totals to $496,320. For the Town to fill in the gaps of the missing curbing it would cost $5,181,792.

It's important for the Town to have a balanced attack of mixed treatments to tackle deteriorating infrastructure and non-compliant sidewalks and ramps. The Town should consider two (2) sidewalk repair programs, one to address localized ramps and sidewalk panel/tree pit repairs and another larger dedicated program toward ramp improvements and block-to-block sidewalk reconstruction in concert with the Towns annual asphalt resurfacing program. Repairing and/or replacing curbing should be in conjunction with any sidewalk or pavement plan.

Arlington has assembled a Commission on Disability to address the needs its constituents. The commission will use the date collected in this study to develop a facility improvement plan and prioritize repairs. Asset management is a systematic

process that needs the long-term commitment and support of Arlington's practitioners and decision-makers to maintain the pedestrian ramp, sidewalk, curbing and tree management database system. The following are general recommendations and standard management and upkeep practices for ramps and sidewalks:

1. Implement a sound departmental quality control/assurance program, with particular focus on ADA standards.
2. Maintain ADA violations in GIS to establish critical regions for immediate repairs.
3. Identify a single individual who will act as a custodian of the maintenance and upkeep of the GIS layer/database. Post the GIS information to a website so stakeholders have access to the information.
4. Update sidewalk segment information where past reconstruction dates are known.
5. During construction season equip inspectors with mobile devices that can be used to update the asset databases with information such as newly constructed ramps, sidewalks, curbs and roadways thereby populating the database with new and current information.
6. Do not delete features that no longer exist. Retire" these features instead.
7. Include historical as-built construction dates in the database, for each ramp to categorize post & pre ADA ramps. The ADA standards for accessible design changed January 26, 1992. Categorizing the ramp database by this date allows DPW to maximize priority spending.
8. Post all annual pedestrian ramp, sidewalk curbing improvements into the GIS database. Both the pedestrian ramp condition ratings and the repair history information should be entered. Track ADA ramp variance requests and grants in a GIS.
9. Add any new pedestrian ramps, sidewalks and curbs to the database as soon as the Town accepts them.
10. Re-inspect pedestrian ramps, sidewalks and curbs periodically.

7

Appendices

Appendices and Deliverables Note

The following pages contain summaries of the quantity of each feature type listed by street. The actual full listing of each item inventoried and all attributes are being delivered to the town via a GIS database, and excel worksheets. Those are the documents that the town will use to prioritize and plan repairs and improvements.

Appendix A – Sidewalk Inventory by Street

Appendix A: Sidewalk Inventory by Street

Street / Material	Total Length (FT)
ABERDEEN ROAD	
Bituminous Concrete	191
None	445
Portland Cement Concrete	713
ACADEMY STREET	
Bituminous Concrete	1,761
Brick	760
Portland Cement Concrete	482
ACTON STREET	
Bituminous Concrete	544
None	267
Portland Cement Concrete	671
ADAMS STREET	
Portland Cement Concrete	1,781
ADDISON STREET	
Bituminous Concrete	1,552
None	32
AERIAL STREET	
None	669
Portland Cement Concrete	830
ALBERMARLE ST	
Portland Cement Concrete	794
ALFRED ROAD	
Portland Cement Concrete	1,118
ALLEN STREET	
Portland Cement Concrete	2,179
ALPINE TERRACE	
None	609
ALTON STREET	
Brick	115
Portland Cement Concrete	1,037
AMHERST STREET	
Portland Cement Concrete	1,061

Street / Material	Total Length (FT)
AMSDEN STREET	
Portland Cement Concrete	1,941
ANDREW STREET	
Portland Cement Concrete	719
APACHE TRAIL	
None	1,752
APPLETON PLACE	
Bituminous Concrete	478
Portland Cement Concrete	1,317
APPLETON STREET	
Bituminous Concrete	6,016
None	1,950
Portland Cement Concrete	4,792
ARGYLE ROAD	
Portland Cement Concrete	1,050
ARNOLD STREET	
Bituminous Concrete	1,281
ARROWHEAD LANE	
None	1,067
ASHLAND STREET	
Bituminous Concrete	1,032
None	213
Portland Cement Concrete	345
AVON PLACE	
Bituminous Concrete	393
None	205
Portland Cement Concrete	302
BACON STREET	
Bituminous Concrete	74
None	136
Portland Cement Concrete	502
BAILEY ROAD	
Portland Cement Concrete	1,696

	Total Length (FT)
BAKER ROAD	
None	1,329
BARTLETT AVENUE	
Bituminous Concrete	709
None	669
Portland Cement Concrete	2,789
BATES ROAD	
Portland Cement Concrete	2,340
BEACON STREET	
None	86
Portland Cement Concrete	2,949
BELKNAP STREET	
Portland Cement Concrete	1,251
BELLINGTON ST	
Portland Cement Concrete	2,000
BELTON STREET	
Portland Cement Concrete	1,084
BERKELEY STREET	
Bituminous Concrete	179
None	484
Portland Cement Concrete	381
BEVERLY ROAD	
Bituminous Concrete	4,094
BLOSSOM STREET	
Bituminous Concrete	1,175
None	405
Portland Cement Concrete	488
BONAD ROAD	
Portland Cement Concrete	976
BOULEVARD ROAD	
None	1,207
Portland Cement Concrete	627
BOW STREET	
Bituminous Concrete	2,983
Portland Cement Concrete	606

	Total Length (FT)
BOWDOIN STREET	
Portland Cement Concrete	1,062
BRADLEY ROAD	
Bituminous Concrete	522
BRANTWOOD ROAD	
Bituminous Concrete	3,372
BRATTLE STREET	
Bituminous Concrete	2,804
None	33
Portland Cement Concrete	292
BRATTLE TERRACE	
Bituminous Concrete	726
None	119
BROADWAY	
Bituminous Concrete	1,380
Brick	956
None	231
Portland Cement Concrete	6,385
BROOKDALE ROAD	
Portland Cement Concrete	787
BROOKS AVENUE	
Bituminous Concrete	13
Portland Cement Concrete	3,964
BROWNING ROAD	
None	2,895
BUENA VISTA ROAD	
Portland Cement Concrete	571
BURCH STREET	
None	428
Portland Cement Concrete	1,517
BURTON STREET	
Portland Cement Concrete	717
CANDIA STREET	
None	1,519

	Total Length (FT)
CARL ROAD	
Bituminous Concrete	571
None	513
CEDAR AVENUE	
Bituminous Concrete	1,582
None	838
CENTRAL STREET	
None	23
Portland Cement Concrete	1,015
CHANDLER STREET	
Portland Cement Concrete	2,273
CHAPMAN STREET	
None	488
CHARLES STREET	
None	949
CHARLTON ST	
None	1,888
CHATHAM STREET	
Bituminous Concrete	1,226
CHEROKEE ROAD	
None	1,573
CHESTER STREET	
Portland Cement Concrete	2,075
CHESTNUT STREET	
Bituminous Concrete	186
Portland Cement Concrete	765
CHESTNUT TERRACE	
Bituminous Concrete	340
None	571
CHURCHILL AVENUE	
None	73
Portland Cement Concrete	2,793
CLAREMONT AVENUE	
Bituminous Concrete	2,755
None	251

	Total Length (FT)
Portland Cement Concrete	1,173
CLEVELAND STREET	
Portland Cement Concrete	3,189
CLIFF STREET	
Bituminous Concrete	1,394
CLYDE TERRACE	
None	359
COLEMAN ROAD	
Portland Cement Concrete	1,003
COLLEGE AVENUE	
Bituminous Concrete	1,899
None	1,217
COLUMBIA ROAD	
Bituminous Concrete	688
Portland Cement Concrete	2,239
COMPTON STREET	
Portland Cement Concrete	481
CONCORD TURNPIKE	
Bituminous Concrete	2,883
None	6,472
CORAL STREET	
None	264
Portland Cement Concrete	263
COREY LANE	
None	363
CORNELL STREET	
Portland Cement Concrete	1,056
COUNTRY CLUB DR	
None	1,280
COURT STREET	
None	234
Portland Cement Concrete	863
CRAWFORD STREET	
Bituminous Concrete	1,399

	Total Length (FT)
CRESCENT HILL	
Bituminous Concrete	344
None	1,856
Portland Cement Concrete	482
CROSBY STREET	
Bituminous Concrete	3,334
None	495
Portland Cement Concrete	1,543
CUTTER HILL ROAD	
Bituminous Concrete	792
CYPRESS ROAD	
Bituminous Concrete	1,025
DANIELS STREET	
Portland Cement Concrete	956
DARTMOUTH STREET	
Portland Cement Concrete	1,065
DAVIS AVENUE	
Bituminous Concrete	601
Portland Cement Concrete	1,080
DAVIS ROAD	
Bituminous Concrete	390
Portland Cement Concrete	411
DAY STREET	
None	808
DECATUR STREET	
Bituminous Concrete	1,037
None	672
Portland Cement Concrete	1,099
DEVEREAUX STREET	
None	32
Portland Cement Concrete	975
DICKSON AVENUE	
None	3,217
DODGE STREET	
None	1,146

	Total Length (FT)
DOROTHY ROAD	
Bituminous Concrete	664
None	489
Portland Cement Concrete	1,194
DOTHAN STREET	
None	1,424
DOW AVENUE	
Bituminous Concrete	2,164
None	749
DOW AVENUE NORTHERLY	
None	111
Portland Cement Concrete	1,980
DRAKE ROAD	
Portland Cement Concrete	631
DRAPER AVENUE	
Bituminous Concrete	1,280
Portland Cement Concrete	227
DUDLEY STREET	
Bituminous Concrete	2,519
Portland Cement Concrete	238
DUNDEE ROAD	
Bituminous Concrete	129
Portland Cement Concrete	1,047
DUNSTER LANE	
None	170
EASTERN AVENUE	
Other	179
Portland Cement Concrete	3,590
EDGEHILL ROAD	
Bituminous Concrete	767
Portland Cement Concrete	1,506
EDITH STREET	
Portland Cement Concrete	582
EDMUND ROAD	
Portland Cement Concrete	989

	Total Length (FT)
EGERTON ROAD	
Portland Cement Concrete	2,512
ELMORE STREET	
Bituminous Concrete	290
None	409
Portland Cement Concrete	309
ELWERN ROAD	
None	695
ENDICOTT ROAD	
Portland Cement Concrete	1,217
EPPING STREET	
None	1,847
EUSTIS STREET	
Bituminous Concrete	1,865
EVERETT STREET	
Bituminous Concrete	1,111
Portland Cement Concrete	4,127
EXETER STREET	
Portland Cement Concrete	1,457
FABYAN STREET	
None	956
FAIRMONT STREET	
None	32
Portland Cement Concrete	3,239
FAIRVIEW AVENUE	
Bituminous Concrete	1,248
Portland Cement Concrete	278
FALMOUTH ROAD	
None	1,582
Portland Cement Concrete	533
FALMOUTH ROAD W	
Portland Cement Concrete	651
FARMER ROAD	
Portland Cement Concrete	741
FARRINGTON ST	

	Total Length (FT)
Bituminous Concrete	677
FAYETTE STREET	
Portland Cement Concrete	1,407
FIELD ROAD	
None	97
Portland Cement Concrete	1,011
FISHER ROAD	
Portland Cement Concrete	1,731
FLORENCE AVENUE	
Bituminous Concrete	4,820
None	1,075
Portland Cement Concrete	1,978
FORDHAM STREET	
Portland Cement Concrete	1,060
FOREST STREET	
Bituminous Concrete	2,945
None	1,773
Portland Cement Concrete	3,983
FOSTER STREET	
Portland Cement Concrete	2,052
FOUNTAIN ROAD	
Portland Cement Concrete	1,626
FOX MEADOW LANE	
None	2,748
FRANKLIN STREET	
Brick	174
None	162
Portland Cement Concrete	4,637
FRAZER ROAD	
None	2,055
FREEMAN STREET	
Portland Cement Concrete	1,899
FREMONT STREET	
Bituminous Concrete	509
Portland Cement Concrete	1,888

	Total Length (FT)
FROST STREET	
Portland Cement Concrete	1,420
GARDNER STREET	
Bituminous Concrete	721
None	556
Portland Cement Concrete	1,677
GAY STREET	
None	409
GEORGE STREET	
Bituminous Concrete	3,189
None	787
Portland Cement Concrete	1,057
GLEN AVENUE	
None	37
Portland Cement Concrete	990
GLENBURN ROAD	
None	231
Portland Cement Concrete	2,461
GLOUCESTER ST	
Other	188
Portland Cement Concrete	3,335
GOLDEN AVENUE	
None	1,480
GORHAM STREET	
None	1,110
GOULD ROAD	
None	40
Portland Cement Concrete	1,063
GRAFTON STREET	
Portland Cement Concrete	2,784
GRANTON PARK	
Bituminous Concrete	735
GRAY CIRCLE	
None	403
GRAY STREET	

	Total Length (FT)
Bituminous Concrete	4,771
Brick	449
None	1,271
Other	102
Portland Cement Concrete	4,716
GREELEY CIRCLE	
None	1,715
GREENWOOD ROAD	
None	638
GROVE ST PLACE	
None	1,062
GROVE STREET	
Bituminous Concrete	2,433
None	70
Portland Cement Concrete	315
HADLEY COURT	
Bituminous Concrete	178
None	224
HAMLET STREET	
Portland Cement Concrete	2,083
HANCOCK STREET	
None	1,391
HARLOW STREET	
Portland Cement Concrete	2,573
HAROLD STREET	
Bituminous Concrete	394
Portland Cement Concrete	62
HARTFORD ROAD	
None	1,324
HARVARD STREET	
None	36
Portland Cement Concrete	1,379
HATHAWAY CIRCLE	
None	4,477

	Total Length (FT)
HAYES STREET	
Portland Cement Concrete	968
HEARD ROAD	
Bituminous Concrete	662
Portland Cement Concrete	138
HEATH ROAD	
Bituminous Concrete	460
None	322
HEMLOCK STREET	
Bituminous Concrete	927
None	1,868
Portland Cement Concrete	1,163
HENDERSON STREET	
Portland Cement Concrete	1,993
HENRY STREET	
None	925
HERBERT ROAD	
Portland Cement Concrete	3,608
HIAWATHA LANE	
None	582
HIBBERT STREET	
None	650
Portland Cement Concrete	2,205
HIGGINS STREET	
Portland Cement Concrete	755
HIGH HAITH ROAD	
Bituminous Concrete	240
None	681
Portland Cement Concrete	1,542
HIGHLAND AVENUE	
Bituminous Concrete	1,234
Portland Cement Concrete	5,729
HILLCREST STREET	
Bituminous Concrete	574
None	163

	Total Length (FT)
HILLSDALE ROAD	
Portland Cement Concrete	2,123
HILLSIDE AVENUE	
Bituminous Concrete	4,956
None	526
Portland Cement Concrete	2,337
HILTON STREET	
Bituminous Concrete	912
HODGE ROAD	
None	915
HOMER ROAD	
None	2,053
HOMESTEAD ROAD	
Portland Cement Concrete	400
HOPKINS ROAD	
Bituminous Concrete	590
None	145
Portland Cement Concrete	595
HOWARD STREET	
Portland Cement Concrete	965
HUNTINGTON ROAD	
Bituminous Concrete	1,433
None	322
HUTCHINSON ROAD	
Bituminous Concrete	171
None	5,565
INVERNESS ROAD	
None	32
Portland Cement Concrete	838
IROQUOIS ROAD	
Portland Cement Concrete	926

	Total Length (FT)
IRVING STREET	
Bituminous Concrete	1,021
Brick	129
None	610
Portland Cement Concrete	534
IVY CIRCLE	
None	696
JASON STREET	
Bituminous Concrete	2,832
Brick	417
Portland Cement Concrete	4,293
JASON TERRACE	
None	343
Portland Cement Concrete	81
JEAN ROAD	
Portland Cement Concrete	814
JOHNSON ROAD	
Portland Cement Concrete	1,075
JOYCE ROAD	
Bituminous Concrete	1,512
KEATS ROAD	
None	388
KENSINGTON PARK	
Portland Cement Concrete	2,886
KENSINGTON ROAD	
None	435
Portland Cement Concrete	1,148
KILSYTHE ROAD	
Portland Cement Concrete	1,158
KIMBALL ROAD	
None	39
Portland Cement Concrete	1,353
KING STREET	
None	508
KIPLING ROAD	

	Total Length (FT)
None	965
LAFAYETTE STREET	
Portland Cement Concrete	1,693
LAKE STREET	
Bituminous Concrete	4,001
Portland Cement Concrete	2,679
LAKEHILL AVENUE	
Portland Cement Concrete	1,200
LAKEVIEW ROAD	
None	40
Portland Cement Concrete	1,050
LANARK ROAD	
Portland Cement Concrete	807
LANCASTER ROAD	
Bituminous Concrete	1,600
None	49
LANGLEY ROAD	
Portland Cement Concrete	963
LANSDOWNE ROAD	
None	821
LANTERN LANE	
None	2,852
LAUREL STREET	
Bituminous Concrete	392
None	431
LAWRENCE LANE	
None	974
LEHIGH STREET	
None	395
LENNON ROAD	
None	1,414
Portland Cement Concrete	753
LEWIS AVENUE	
None	125
Portland Cement Concrete	1,316

	Total Length (FT)
LINCOLN STREET	
None	287
Portland Cement Concrete	418
LINDEN STREET	
Bituminous Concrete	1,168
None	443
LINWOOD STREET	
None	31
Portland Cement Concrete	1,280
LITTLEJOHN ST	
Bituminous Concrete	399
Portland Cement Concrete	757
LOCKE STREET	
Bituminous Concrete	784
None	40
LOCKELAND AVE	
None	122
Portland Cement Concrete	1,995
LOMBARD ROAD	
Portland Cement Concrete	923
LOMBARD TERRACE	
None	1,124
Other	484
LONGFELLOW ROAD	
None	737
Portland Cement Concrete	1,005
LONGMEADOW ROAD	
None	2,346
LORNE ROAD	
None	387
Portland Cement Concrete	178
LORRAINE TERRACE	
None	1,326
LOWELL ST PLACE	
Bituminous Concrete	300

	Total Length (FT)
None	333
LOWELL STREET	
Bituminous Concrete	1,725
None	2,490
Portland Cement Concrete	3,034
MAGNOLIA STREET	
Portland Cement Concrete	2,110
MAPLE STREET	
Bituminous Concrete	1,010
Brick	206
Portland Cement Concrete	153
MARATHON STREET	
Portland Cement Concrete	3,243
MARGARET STREET	
None	30
Portland Cement Concrete	1,999
MARION CIRCLE	
Bituminous Concrete	514
MARION ROAD	
Bituminous Concrete	1,379
MARRIGAN STREET	
Bituminous Concrete	693
MARY STREET	
Bituminous Concrete	1,060
Portland Cement Concrete	2,311
MASSACHUSETTS	
Bituminous Concrete	1,069
Brick	5,544
None	972
Portland Cement Concrete	24,408
MASSACHUSETTS AVE (WB)	
Brick	1,308
None	188
MAYNARD STREET	
Portland Cement Concrete	1,888

	Total Length (FT)
MEAD ROAD	
None	992
MEDFORD ST	
Bituminous Concrete	1,616
None	41
Portland Cement Concrete	3,952
MELANIE LANE	
None	1,069
MELROSE STREET	
Portland Cement Concrete	2,732
MELVIN ROAD	
None	892
MEMORIAL WAY	
Portland Cement Concrete	776
MENOTOMY ROAD	
Portland Cement Concrete	2,691
MENOTOMY ROCKS	
None	826
MICHAEL STREET	
Bituminous Concrete	1,245
MILL BROOK DRIVE	
None	1,336
Portland Cement Concrete	517
MILL STREET	
Portland Cement Concrete	1,621
MILTON STREET	
Portland Cement Concrete	2,932
MOCCASIN PATH	
None	628
MODENA STREET	
None	374
MOHAWK ROAD	
None	1,239
MONTAGUE STREET	
None	621

	Total Length (FT)
MORNINGSIDE DR	
Bituminous Concrete	2,176
None	1,351
Portland Cement Concrete	94
MOTT STREET	
Bituminous Concrete	2,545
None	328
MOULTON ROAD	
Portland Cement Concrete	1,498
MOUNTAIN AVENUE	
Bituminous Concrete	1,650
None	1,915
MT VERNON STREET	
Portland Cement Concrete	5,107
MYSTIC LAKE DR	
Portland Cement Concrete	1,295
MYSTIC ST (NB)	
Brick	190
None	387
Portland Cement Concrete	325
MYSTIC STREET	
Bituminous Concrete	10,304
None	1,965
Portland Cement Concrete	1,407
MYSTIC STREET (SB)	
Brick	137
None	286
Portland Cement Concrete	489
NEWCOMB STREET	
Bituminous Concrete	157
None	335
Portland Cement Concrete	1,398
NEWLAND ROAD	
Portland Cement Concrete	3,724
NEWMAN WAY	
Portland Cement Concrete	1,203

	Total Length (FT)
NEWPORT STREET	
Portland Cement Concrete	5,696
NEWTON ROAD	
Portland Cement Concrete	775
NICOD STREET	
None	1,719
NORCROSS STREET	
Bituminous Concrete	1,456
NORFOLK ROAD	
Portland Cement Concrete	2,169
NORTH UNION ST	
Bituminous Concrete	1,100
None	761
Portland Cement Concrete	1,752
NOURSE ROAD	
Bituminous Concrete	664
None	28
OAK HILL DRIVE	
Bituminous Concrete	2,904
None	128
OAK KNOLL	
None	293
Portland Cement Concrete	421
OAKLAND AVENUE	
Bituminous Concrete	1,991
None	3,803
Portland Cement Concrete	2,165
OAKLEDGE STREET	
Bituminous Concrete	643
OLD COLONY ROAD	
None	2,639
OLD MIDDLESEX	
None	2,143
OLD MYSTIC ST	
Bituminous Concrete	768

	Total Length (FT)
None	3,182
OLD SPRING ST	
None	926
OLDHAM ROAD	
None	1,103
ORCHARD TERRACE	
Portland Cement Concrete	649
ORIENT AVENUE	
None	455
ORVIS RD (SB)	
None	880
Portland Cement Concrete	770
ORVIS ROAD (NB)	
None	403
Portland Cement Concrete	827
OSBORNE ROAD	
Portland Cement Concrete	530
OSCEOLA PATH	
None	595
OTTAWA ROAD	
None	87
Portland Cement Concrete	1,097
OVERLOOK ROAD	
Bituminous Concrete	1,823
Portland Cement Concrete	2,890
OXFORD STREET	
Portland Cement Concrete	2,886
PALMER STREET	
Portland Cement Concrete	5,129
PARALLEL STREET	
Portland Cement Concrete	818
PARK AVE	
Bituminous Concrete	4,505
Portland Cement Concrete	1,042

	Total Length (FT)
PARK AVENUE	
Bituminous Concrete	1,189
Brick	281
None	605
Portland Cement Concrete	2,578
PARK AVENUE EXT	
None	40
Portland Cement Concrete	4,682
PARK CIRCLE	
Bituminous Concrete	635
None	1,168
Portland Cement Concrete	369
PARK STREET	
Portland Cement Concrete	2,915
PARKER STREET	
Portland Cement Concrete	750
PATRICK STREET	
None	782
PAUL REVERE ROAD	
Bituminous Concrete	990
None	199
Portland Cement Concrete	3,015
PAWNEE DRIVE	
None	1,237
PECK AVENUE	
None	683
PEIRCE STREET	
Portland Cement Concrete	1,300
PELHAM TERRACE	
Bituminous Concrete	662
None	28
PETER TUFTS ROAD	
Portland Cement Concrete	1,132
PHEASANT AVENUE	
Bituminous Concrete	1,448

	Total Length (FT)
None	888
PHILIPS STREET	
Portland Cement Concrete	1,182
PIEDMONT STREET	
None	348
PINE RIDGE ROAD	
Bituminous Concrete	965
None	97
Portland Cement Concrete	1,458
PINE STREET	
None	402
Portland Cement Concrete	974
PLEASANT STREET	
Bituminous Concrete	33
Brick	207
None	55
Other	249
Portland Cement Concrete	7,766
PLEASANT VIEW RD	
Bituminous Concrete	2,004
Portland Cement Concrete	89
PLYMOUTH STREET	
Portland Cement Concrete	656
POND LANE	
Bituminous Concrete	965
None	213
PONDVIEW ROAD	
Portland Cement Concrete	1,152
PRESCOTT STREET	
None	87
Portland Cement Concrete	948
PROSPECT AVENUE	
None	622
PURCELL ROAD	
None	391
Portland Cement Concrete	407

	Total Length (FT)
QUINCY STREET	
Portland Cement Concrete	2,613
QUINN ROAD	
None	606
RADCLIFF ROAD	
Portland Cement Concrete	621
RALEIGH STREET	
Bituminous Concrete	1,602
Portland Cement Concrete	398
RANDOLPH STREET	
Portland Cement Concrete	1,723
RANGELEY ROAD	
Portland Cement Concrete	1,165
RAVINE STREET	
None	238
Portland Cement Concrete	507
RAWSON ROAD	
Portland Cement Concrete	3,216
RENFREW STREET	
None	2,303
Portland Cement Concrete	1,999
RESERVOIR ROAD	
Bituminous Concrete	462
None	32
REVERE STREET	
Portland Cement Concrete	747
RHINECLIFF ST	
Bituminous Concrete	4,530
None	676
RICHARDSON AVE	
Portland Cement Concrete	784
RICHFIELD ROAD	
Bituminous Concrete	875
Portland Cement Concrete	3,294
RIDGE STREET	

	Total Length (FT)
Bituminous Concrete	3,685
None	8,513
RIVER STREET	
Bituminous Concrete	177
None	774
Portland Cement Concrete	2,049
ROBBINS ROAD	
Portland Cement Concrete	2,608
ROCKMONT ROAD	
Bituminous Concrete	1,559
RONALD ROAD	
Portland Cement Concrete	2,713
RUBLEE STREET	
Bituminous Concrete	108
None	2,880
RUSSELL STREET	
Portland Cement Concrete	1,503
RUSSELL TERRACE	
Portland Cement Concrete	763
SAGAMORE ROAD	
Bituminous Concrete	60
None	50
SARATOGA ROAD	
Bituminous Concrete	551
SAWIN STREET	
None	225
Portland Cement Concrete	223
SCHOOL STREET	
Portland Cement Concrete	2,724
SCHOULER COURT	
None	336
Portland Cement Concrete	468
SCITUATE STREET	
Portland Cement Concrete	4,562

	Total Length (FT)
SEMINOLE AVENUE	
None	453
SHAWNEE ROAD	
Portland Cement Concrete	1,099
SHERBORN STREET	
Portland Cement Concrete	1,212
SILK STREET	
Bituminous Concrete	1,374
Portland Cement Concrete	421
SLEEPY HOLLOW LA	
None	588
SORENSON COURT	
None	430
SPRING AVENUE	
Portland Cement Concrete	412
SPRING STREET	
None	4,459
Portland Cement Concrete	608
STONE ROAD	
None	1,154
STOWECROFT ROAD	
Bituminous Concrete	789
None	1,586
Portland Cement Concrete	353
SUMMER STREET	
Bituminous Concrete	3,722
None	1,704
Portland Cement Concrete	14,125
SUMMIT STREET	
None	829
SUNNYSIDE AVENUE	
Bituminous Concrete	2,810
None	41
Portland Cement Concrete	953
SUNSET ROAD	

	Total Length (FT)
Bituminous Concrete	616
None	99
Portland Cement Concrete	2,638
SURRY ROAD	
Portland Cement Concrete	1,041
SUTHERLAND ROAD	
None	55
Portland Cement Concrete	1,457
SWAN PLACE	
None	489
Portland Cement Concrete	704
SWAN STREET	
Portland Cement Concrete	522
SYLVIA STREET	
None	2,889
TANAGER STREET	
Bituminous Concrete	147
None	929
Portland Cement Concrete	1,221
TEEL STREET	
Portland Cement Concrete	1,980
TEMPLE STREET	
Portland Cement Concrete	1,827
TERESA CIRCLE	
None	1,685
THESDA STREET	
None	449
THORNDIKE STREET	
Bituminous Concrete	295
Portland Cement Concrete	2,827
TOMAHAWK ROAD	
None	2,551
TOWER ROAD	
None	1,270

	Total Length (FT)
TROWBRIDGE ST	
Portland Cement Concrete	2,032
TUFTS STREET	
Bituminous Concrete	228
Portland Cement Concrete	2,280
TWIN CIRCLE DR	
None	1,235
UDINE STREET	
Bituminous Concrete	630
None	1,217
UNIVERSITY ROAD	
Bituminous Concrete	925
UPLAND ROAD	
Portland Cement Concrete	557
UPLAND ROAD WEST	
Bituminous Concrete	841
None	921
VALENTINE ROAD	
Bituminous Concrete	2,132
None	1,364
VARNUM STREET	
None	32
Portland Cement Concrete	3,227
VENNER ROAD	
None	204
Portland Cement Concrete	1,216
VICTORIA ROAD	
Portland Cement Concrete	1,341
VIRGINIA ROAD	
Bituminous Concrete	1,474
W. COURT TERRACE	
None	57
Portland Cement Concrete	427
WACHUSETT AVENUE	
Bituminous Concrete	2,118

	Total Length (FT)
Portland Cement Concrete	3,940
WADSWORTH ROAD	
Bituminous Concrete	746
None	1,394
WALDO ROAD	
None	205
Portland Cement Concrete	1,677
WALNUT COURT	
None	572
WALNUT STREET	
Bituminous Concrete	1,773
None	560
Portland Cement Concrete	209
WALNUT TERRACE	
Bituminous Concrete	666
Portland Cement Concrete	538
WARREN STREET	
Portland Cement Concrete	4,785
WASHINGTON ST	
Bituminous Concrete	410
None	3,240
Portland Cement Concrete	4,637
WATER STREET	
Brick	462
None	97
Portland Cement Concrete	828
WAVERLY STREET	
Bituminous Concrete	3,347
None	796
WEBCOWET ROAD	
Portland Cement Concrete	2,038
WEBSTER STREET	
Portland Cement Concrete	4,364
WELLESLEY ROAD	
None	906

Street / Material	Total Length (FT)
WELLINGTON ST	
None	286
Portland Cement Concrete	1,404
WEST STREET	
Bituminous Concrete	852
WESTMINSTER AVE	
Bituminous Concrete	865
None	1,628
Portland Cement Concrete	1,949
WESTMORELAND AVE	
Bituminous Concrete	531
None	616
WHEATON ROAD	
None	817
WHEELER LANE	
None	386
WHITE STREET	
Portland Cement Concrete	538
WHITTEMORE ST	
Brick	731
Portland Cement Concrete	242
WIGWAM CIRCLE	
None	523
WILBUR AVENUE	
None	2,531
WILDWOOD AVENUE	
None	90
Portland Cement Concrete	3,117
WILLIAMS STREET	
Bituminous Concrete	2,789
WINCHESTER ROAD	
Bituminous Concrete	280
None	1,550
Portland Cement Concrete	1,566
WINDERMERE AVE	
None	115
Portland Cement Concrete	989
WINDMILL LANE	
None	541
WINDSOR STREET	
Portland Cement Concrete	2,004
WINSLOW STREET	
Bituminous Concrete	72
None	313
Portland Cement Concrete	363
WINTER STREET	
Portland Cement Concrete	3,092
WOLLASTON AVENUE	
Bituminous Concrete	3,543
None	1,216
Portland Cement Concrete	1,373
WOODLAND STREET	
None	383
Portland Cement Concrete	669
WOODSIDE LANE	
None	3,416
WRIGHT STREET	
None	2,967
WYMAN STREET	
Bituminous Concrete	147
Portland Cement Concrete	1,969
WYMAN TERRACE	
Bituminous Concrete	86
Portland Cement Concrete	1,435
YALE ROAD	
None	963
YERXA ROAD	
None	2,475

Appendix B – Ramp Inventory by Street

Reference 8

Appendix B: Ramps Material Report

		Total
ABERDEEN ROAD		
	Missing	7
ACADEMY STREET		
	Portland Cement Concrete	5
ACTON STREET		
	Bituminous Concrete	1
	Portland Cement Concrete	6
ADAMS STREET		
	Portland Cement Concrete	4
ADDISON STREET		
	Other	1
	Portland Cement Concrete	1
AERIAL STREET		
	Portland Cement Concrete	1
ALBERMARLE ST		
	Portland Cement Concrete	2
ALFRED ROAD		
	Missing	2
	Portland Cement Concrete	2
ALLEN STREET		
	Portland Cement Concrete	9
ALTON STREET		
	Brick	2
	Missing	1
	Portland Cement Concrete	3
AMHERST STREET		
	Portland Cement Concrete	3
AMSDEN STREET		
	Portland Cement Concrete	3
ANDREW STREET		
	Portland Cement Concrete	3
APPLETON PLACE		
	Missing	6
	Portland Cement Concrete	3
APPLETON STREET		
	Bituminous Concrete	10
	Missing	25
	Portland Cement Concrete	8
ARGYLE ROAD		
	Missing	2

		Total
ARNOLD STREET		
	Missing	7
ASHLAND STREET		
	Missing	3
	Portland Cement Concrete	1
AVON PLACE		
	Brick	1
	Portland Cement Concrete	1
BACON STREET		
	Portland Cement Concrete	3
BAILEY ROAD		
	Portland Cement Concrete	2
BARTLETT AVENUE		
	Missing	7
	Portland Cement Concrete	4
BATES ROAD		
	Portland Cement Concrete	2
BEACON STREET		
	Portland Cement Concrete	3
BELKNAP STREET		
	Portland Cement Concrete	2
BELLINGTON ST		
	Missing	7
BELTON STREET		
	Portland Cement Concrete	1
BEVERLY ROAD		
	Bituminous Concrete	3
BLOSSOM STREET		
	Bituminous Concrete	1
	Missing	4
	Portland Cement Concrete	8
BONAD ROAD		
	Portland Cement Concrete	5
BOULEVARD ROAD		
	Portland Cement Concrete	4
BOW STREET		
	Bituminous Concrete	5
	Missing	6
	Portland Cement Concrete	4

	Total
BOWDOIN STREET	
Portland Cement Concrete	3
BRADLEY ROAD	
Missing	4
BRANTWOOD ROAD	
Portland Cement Concrete	3
BRATTLE STREET	
Bituminous Concrete	6
Brick	1
Missing	2
Portland Cement Concrete	4
BRATTLE TERRACE	
Missing	1
BROADWAY	
Brick	2
Missing	4
Portland Cement Concrete	5
BROOKDALE ROAD	
Portland Cement Concrete	4
BROOKS AVENUE	
Bituminous Concrete	1
Missing	1
Portland Cement Concrete	12
BROWNING ROAD	
Bituminous Concrete	1
BUENA VISTA ROAD	
Missing	2
BURCH STREET	
Portland Cement Concrete	11
CAMPBELL ROAD	
Missing	2
CANDIA STREET	
Portland Cement Concrete	2
CEDAR AVENUE	
Missing	3
Portland Cement Concrete	2
CENTRAL STREET	
Portland Cement Concrete	3
CHANDLER STREET	
Portland Cement Concrete	3

	Total
CHAPMAN STREET	
Portland Cement Concrete	2
CHARLTON ST	
Missing	2
CHATHAM STREET	
Portland Cement Concrete	1
CHESTER STREET	
Missing	2
Portland Cement Concrete	1
CHESTNUT STREET	
Missing	2
Portland Cement Concrete	6
CHESTNUT TERRACE	
Portland Cement Concrete	2
CHURCHILL AVENUE	
Missing	5
Portland Cement Concrete	2
CLAREMONT AVENUE	
Missing	2
Portland Cement Concrete	1
CLEVELAND STREET	
Portland Cement Concrete	5
CLIFF STREET	
Bituminous Concrete	2
Missing	1
COLEMAN ROAD	
Portland Cement Concrete	3
COLLEGE AVENUE	
Bituminous Concrete	1
Missing	3
Portland Cement Concrete	1
COLUMBIA ROAD	
Missing	1
Portland Cement Concrete	13
COMPTON STREET	
Portland Cement Concrete	4
CONCORD TURNPIKE	
Bituminous Concrete	1
Missing	6
Portland Cement Concrete	4

	Total
CORAL STREET	
Portland Cement Concrete	1
CORNELL STREET	
Portland Cement Concrete	3
COURT STREET	
Brick	1
Portland Cement Concrete	3
CRAWFORD STREET	
Missing	2
Portland Cement Concrete	1
CROSBY STREET	
Bituminous Concrete	1
Missing	5
Portland Cement Concrete	4
CUTTER HILL ROAD	
Missing	2
Portland Cement Concrete	2
CYPRESS ROAD	
Portland Cement Concrete	1
DANIELS STREET	
Missing	2
Portland Cement Concrete	3
DARTMOUTH STREET	
Portland Cement Concrete	2
DAVIS AVENUE	
Bituminous Concrete	1
DAVIS ROAD	
Missing	3
Portland Cement Concrete	2
DAY STREET	
Portland Cement Concrete	1
DECATUR STREET	
Missing	4
DEVEREAUX STREET	
Missing	2
DICKSON AVENUE	
Bituminous Concrete	1
DOROTHY ROAD	
Portland Cement Concrete	4

	Total
DOW AVENUE	
Missing	1
Portland Cement Concrete	10
DOW AVENUE NORTHERLY	
Missing	2
DRAKE ROAD	
Portland Cement Concrete	5
DRAPER AVENUE	
Bituminous Concrete	2
DUDLEY STREET	
Bituminous Concrete	1
Missing	1
DUNDEE ROAD	
Missing	4
Portland Cement Concrete	2
EASTERN AVENUE	
Bituminous Concrete	1
Missing	6
Portland Cement Concrete	7
EDGEHILL ROAD	
Portland Cement Concrete	10
EDITH STREET	
Portland Cement Concrete	1
EDMUND ROAD	
Missing	1
EGERTON ROAD	
Portland Cement Concrete	4
ELMORE STREET	
Portland Cement Concrete	1
ENDICOTT ROAD	
Missing	1
Portland Cement Concrete	1
EPPING STREET	
Missing	2
EUSTIS STREET	
Missing	1
EVERETT STREET	
Bituminous Concrete	1
Missing	1
Portland Cement Concrete	20

	Total
EXETER STREET	
Portland Cement Concrete	5
FAIRMONT STREET	
Portland Cement Concrete	5
FAIRVIEW AVENUE	
Bituminous Concrete	2
FALMOUTH ROAD	
Bituminous Concrete	1
Missing	1
FALMOUTH ROAD W	
Missing	3
FARMER ROAD	
Portland Cement Concrete	2
FARRINGTON ST	
Bituminous Concrete	1
Missing	1
FAYETTE STREET	
Missing	2
Portland Cement Concrete	4
FIELD ROAD	
Portland Cement Concrete	1
FISHER ROAD	
Missing	6
FLORENCE AVENUE	
Bituminous Concrete	6
Missing	6
Portland Cement Concrete	15
FORDHAM STREET	
Portland Cement Concrete	2
FOREST STREET	
Bituminous Concrete	4
Missing	2
Portland Cement Concrete	21
FOSTER STREET	
Bituminous Concrete	1
Missing	1
Portland Cement Concrete	6
FOUNTAIN ROAD	
Missing	6

	Total
FRANKLIN STREET	
Brick	6
Portland Cement Concrete	10
FRAZER ROAD	
Missing	1
FREEMAN STREET	
Missing	2
Portland Cement Concrete	3
FREMONT STREET	
Bituminous Concrete	2
Missing	2
Portland Cement Concrete	5
FROST STREET	
Missing	5
GARDNER STREET	
Bituminous Concrete	2
Missing	3
Portland Cement Concrete	3
GEORGE STREET	
Missing	5
Portland Cement Concrete	9
GLEN AVENUE	
Bituminous Concrete	1
GLENBURN ROAD	
Missing	7
Portland Cement Concrete	2
GLOUCESTER ST	
Missing	1
Portland Cement Concrete	15
GORHAM STREET	
Portland Cement Concrete	1
GOULD ROAD	
Missing	2
Portland Cement Concrete	1
GRAFTON STREET	
Portland Cement Concrete	6
GRANTON PARK	
Missing	1
GRAY CIRCLE	
Missing	1

		Total
GRAY STREET		
	Bituminous Concrete	5
	Missing	25
	Portland Cement Concrete	9
GROVE ST PLACE		
	Bituminous Concrete	1
GROVE STREET		
	Bituminous Concrete	1
	Missing	5
	Portland Cement Concrete	3
HADLEY COURT		
	Missing	1
HAMLET STREET		
	Portland Cement Concrete	13
HANCOCK STREET		
	Portland Cement Concrete	2
HARLOW STREET		
	Portland Cement Concrete	7
HARVARD STREET		
	Portland Cement Concrete	1
HAYES STREET		
	Bituminous Concrete	2
	Portland Cement Concrete	8
HEARD ROAD		
	Portland Cement Concrete	1
HEATH ROAD		
	Missing	1
	Portland Cement Concrete	2
HEMLOCK STREET		
	Bituminous Concrete	2
	Missing	4
	Portland Cement Concrete	4
HENDERSON STREET		
	Missing	1
	Other	1
	Portland Cement Concrete	4
HERBERT ROAD		
	Portland Cement Concrete	23
HIBBERT STREET		
	Missing	7
	Portland Cement Concrete	2

		Total
HIGGINS STREET		
	Portland Cement Concrete	1
HIGH HAITH ROAD		
	Missing	4
	Portland Cement Concrete	1
HIGHLAND AVENUE		
	Missing	6
	Portland Cement Concrete	17
HILLCREST STREET		
	Missing	2
HILLSDALE ROAD		
	Missing	7
HILLSIDE AVENUE		
	Bituminous Concrete	1
	Missing	8
	Other	1
	Portland Cement Concrete	10
HILTON STREET		
	Missing	2
HOMER ROAD		
	Missing	1
HOMESTEAD ROAD		
	Portland Cement Concrete	2
HOPKINS ROAD		
	Portland Cement Concrete	2
HOWARD STREET		
	Portland Cement Concrete	1
HUNTINGTON ROAD		
	Missing	2
	Portland Cement Concrete	3
HUTCHINSON ROAD		
	Missing	3
INVERNESS ROAD		
	Missing	1
IROQUOIS ROAD		
	Portland Cement Concrete	2
IRVING STREET		
	Missing	5
	Other	1
	Portland Cement Concrete	4

	Total
IVY CIRCLE	
Missing	1
JASON STREET	
Missing	8
Portland Cement Concrete	9
JASON TERRACE	
Missing	2
JEAN ROAD	
Portland Cement Concrete	4
JOHNSON ROAD	
Portland Cement Concrete	6
JOYCE ROAD	
Missing	3
KENSINGTON PARK	
Other	1
Portland Cement Concrete	3
KENSINGTON ROAD	
Portland Cement Concrete	2
KILSYTHE ROAD	
Missing	6
KIMBALL ROAD	
Portland Cement Concrete	2
LAFAYETTE STREET	
Portland Cement Concrete	5
LAKE ST (EB)	
Missing	4
Portland Cement Concrete	3
LAKE STREET	
Bituminous Concrete	2
Missing	3
Portland Cement Concrete	19
LAKEHILL AVENUE	
Portland Cement Concrete	2
LAKEVIEW ROAD	
Portland Cement Concrete	2
LANARK ROAD	
Missing	2
LANCASTER ROAD	
Missing	6
LANGLEY ROAD	
Missing	2

	Total
LAUREL STREET	
Bituminous Concrete	1
LEHIGH STREET	
Missing	1
LENNON ROAD	
Missing	1
Portland Cement Concrete	1
LEWIS AVENUE	
Portland Cement Concrete	4
LINCOLN STREET	
Missing	2
LINDEN STREET	
Bituminous Concrete	2
Portland Cement Concrete	1
LINWOOD STREET	
Bituminous Concrete	1
Missing	4
Portland Cement Concrete	4
LITTLEJOHN ST	
Portland Cement Concrete	6
LOCKE STREET	
Missing	3
LOCKELAND AVE	
Portland Cement Concrete	7
LOMBARD ROAD	
Missing	2
Portland Cement Concrete	2
LOMBARD TERRACE	
Portland Cement Concrete	1
LONGFELLOW ROAD	
Portland Cement Concrete	3
LOWELL ST PLACE	
Bituminous Concrete	1
LOWELL STREET	
Bituminous Concrete	4
Missing	8
Portland Cement Concrete	9
MAGNOLIA STREET	
Portland Cement Concrete	3
MAPLE STREET	
Portland Cement Concrete	2

Reference 8

Street / Material	Total
MARATHON STREET	
Bituminous Concrete	2
Portland Cement Concrete	7
MARGARET STREET	
Portland Cement Concrete	8
MARION CIRCLE	
Missing	2
MARION ROAD	
Missing	2
Portland Cement Concrete	2
MARRIGAN STREET	
Missing	1
MARY STREET	
Portland Cement Concrete	9
MASSACHUSETTS	
Brick	13
Missing	6
Portland Cement Concrete	65
MASSACHUSETTS AVE (WB)	
Brick	6
MAYNARD STREET	
Portland Cement Concrete	8
MEDFORD ST	
Bituminous Concrete	1
Brick	2
Missing	2
Portland Cement Concrete	17
MELROSE STREET	
Portland Cement Concrete	4
MEMORIAL WAY	
Portland Cement Concrete	4
MENOTOMY ROAD	
Brick	1
Portland Cement Concrete	4
MENOTOMY ROCKS	
Portland Cement Concrete	1
MICHAEL STREET	
Missing	7
MILL BROOK DRIVE	
Portland Cement Concrete	2

Street / Material	Total
MILL LANE	
Portland Cement Concrete	2
MILL STREET	
Portland Cement Concrete	12
MILTON STREET	
Portland Cement Concrete	4
MORNINGSIDE DR	
Missing	10
MOTT STREET	
Portland Cement Concrete	3
MOULTON ROAD	
Portland Cement Concrete	3
MOUNTAIN AVENUE	
Missing	9
MT VERNON STREET	
Missing	6
Portland Cement Concrete	5
MYSTIC LAKE DR	
Bituminous Concrete	2
Portland Cement Concrete	2
MYSTIC ST (NB)	
Brick	1
Portland Cement Concrete	6
MYSTIC STREET	
Bituminous Concrete	14
Missing	7
Portland Cement Concrete	6
MYSTIC STREET (SB)	
Brick	1
Portland Cement Concrete	2
NEWCOMB STREET	
Bituminous Concrete	1
Missing	1
Portland Cement Concrete	5
NEWLAND ROAD	
Portland Cement Concrete	10
NEWMAN WAY	
Portland Cement Concrete	2

	Total
NEWPORT STREET	
Missing	2
Other	1
Portland Cement Concrete	11
NEWTON ROAD	
Portland Cement Concrete	1
NORCROSS STREET	
Bituminous Concrete	1
Missing	4
NORFOLK ROAD	
Portland Cement Concrete	4
NORTH UNION ST	
Bituminous Concrete	3
Missing	4
Portland Cement Concrete	7
NOURSE ROAD	
Bituminous Concrete	1
Missing	2
OAK HILL DRIVE	
Bituminous Concrete	1
Missing	5
Portland Cement Concrete	2
OAK KNOLL	
Portland Cement Concrete	1
OAKLAND AVENUE	
Bituminous Concrete	3
Missing	7
Portland Cement Concrete	7
OAKLEDGE STREET	
Portland Cement Concrete	1
OLD MYSTIC ST	
Bituminous Concrete	1
Portland Cement Concrete	2
ORCHARD TERRACE	
Portland Cement Concrete	2
ORVIS RD (SB)	
Portland Cement Concrete	5
ORVIS ROAD (NB)	
Portland Cement Concrete	4

	Total
OTTAWA ROAD	
Missing	2
Portland Cement Concrete	5
OVERLOOK ROAD	
Bituminous Concrete	3
Missing	8
Portland Cement Concrete	2
OXFORD STREET	
Portland Cement Concrete	6
PALMER STREET	
Portland Cement Concrete	13
PARALLEL STREET	
Portland Cement Concrete	1
PARK AVE	
Bituminous Concrete	5
Missing	3
Portland Cement Concrete	2
PARK AVENUE	
Bituminous Concrete	2
Missing	4
Portland Cement Concrete	11
PARK AVENUE EXT	
Bituminous Concrete	1
Missing	3
Portland Cement Concrete	18
PARK CIRCLE	
Missing	1
Portland Cement Concrete	2
PARK STREET	
Portland Cement Concrete	5
PARKER STREET	
Portland Cement Concrete	5
PATRICK STREET	
Missing	1
PAUL REVERE ROAD	
Bituminous Concrete	1
Portland Cement Concrete	5
PECK AVENUE	
Missing	1
PEIRCE STREET	
Missing	5

	Total
PELHAM TERRACE	
Portland Cement Concrete	2
PETER TUFTS ROAD	
Missing	2
PHEASANT AVENUE	
Missing	6
PHILIPS STREET	
Portland Cement Concrete	7
PINE RIDGE ROAD	
Missing	6
PINE STREET	
Missing	2
PLEASANT STREET	
Bituminous Concrete	2
Missing	4
Other	2
Portland Cement Concrete	14
PLEASANT VIEW RD	
Missing	2
PLYMOUTH STREET	
Portland Cement Concrete	2
POND LANE	
Portland Cement Concrete	2
PONDVIEW ROAD	
Missing	2
Portland Cement Concrete	1
PRESCOTT STREET	
Portland Cement Concrete	2
PROSPECT AVENUE	
Bituminous Concrete	1
Missing	1
PURCELL ROAD	
Portland Cement Concrete	6
QUINCY STREET	
Missing	6
Portland Cement Concrete	3
QUINN ROAD	
Portland Cement Concrete	1
RADCLIFF ROAD	
Portland Cement Concrete	3

	Total
RALEIGH STREET	
Portland Cement Concrete	16
RANDOLPH STREET	
Missing	2
Portland Cement Concrete	4
RANGELEY ROAD	
Missing	5
RAVINE STREET	
Missing	2
RAWSON ROAD	
Portland Cement Concrete	16
RENFREW STREET	
Missing	2
Portland Cement Concrete	6
REVERE STREET	
Portland Cement Concrete	2
RHINECLIFF ST	
Bituminous Concrete	2
Missing	12
Portland Cement Concrete	7
RICHARDSON AVE	
Portland Cement Concrete	3
RICHFIELD ROAD	
Missing	9
Portland Cement Concrete	4
RIDGE STREET	
Missing	3
Portland Cement Concrete	7
RIVER STREET	
Bituminous Concrete	1
Missing	2
Portland Cement Concrete	5
ROBBINS ROAD	
Bituminous Concrete	1
Missing	1
Portland Cement Concrete	6
ROCKMONT ROAD	
Missing	2

	Total
RONALD ROAD	
	1
Missing	2
Portland Cement Concrete	1
RUBLEE STREET	
Missing	2
RUSSELL STREET	
Bituminous Concrete	1
Portland Cement Concrete	2
RUSSELL TERRACE	
Portland Cement Concrete	4
SAGAMORE ROAD	
Missing	1
SARATOGA ROAD	
Missing	1
SAWIN STREET	
Portland Cement Concrete	3
SCHOOL STREET	
Brick	1
Portland Cement Concrete	3
SCHOULER COURT	
Portland Cement Concrete	4
SCITUATE STREET	
Portland Cement Concrete	13
SHERBORN STREET	
Portland Cement Concrete	3
SILK STREET	
Missing	4
Portland Cement Concrete	2
SPRING AVENUE	
Portland Cement Concrete	3
SPRING STREET	
Missing	3
Portland Cement Concrete	5
SPRING VALLEY	
Portland Cement Concrete	1
STOWECROFT ROAD	
Portland Cement Concrete	1
SUMMER STREET	
Missing	4
Portland Cement Concrete	78

	Total
SUMMIT STREET	
Portland Cement Concrete	1
SUNNYSIDE AVENUE	
Missing	4
Portland Cement Concrete	3
SUNSET ROAD	
Missing	3
Portland Cement Concrete	5
SURRY ROAD	
Missing	1
SUTHERLAND ROAD	
Missing	8
Portland Cement Concrete	1
SWAN PLACE	
Missing	2
Other	1
Portland Cement Concrete	2
SWAN STREET	
Portland Cement Concrete	4
TANAGER STREET	
Bituminous Concrete	1
Portland Cement Concrete	2
TEEL STREET	
Missing	5
Portland Cement Concrete	3
TEMPLE STREET	
Portland Cement Concrete	6
THORNDIKE STREET	
Bituminous Concrete	1
Portland Cement Concrete	4
TROWBRIDGE ST	
Missing	2
Portland Cement Concrete	2
TUFTS STREET	
Missing	1
Portland Cement Concrete	14
UDINE STREET	
Missing	2
UNIVERSITY ROAD	
Portland Cement Concrete	4

	Total
UPLAND ROAD	
Missing	2
UPLAND ROAD WEST	
Missing	2
VALENTINE ROAD	
Missing	2
VARNUM STREET	
Portland Cement Concrete	4
VENNER ROAD	
Missing	2
VICTORIA ROAD	
Portland Cement Concrete	2
VIRGINIA ROAD	
Portland Cement Concrete	2
W. COURT TERRACE	
Portland Cement Concrete	1
WACHUSETT AVENUE	
Bituminous Concrete	1
Missing	5
Portland Cement Concrete	4
WADSWORTH ROAD	
Bituminous Concrete	3
Missing	2
WALDO ROAD	
Portland Cement Concrete	7
WALNUT COURT	
Missing	1
WALNUT STREET	
Missing	5
Portland Cement Concrete	4
WALNUT TERRACE	
Missing	1
WARREN STREET	
Missing	1
Portland Cement Concrete	9
WASHINGTON ST	
	1
Missing	2
Portland Cement Concrete	25

	Total
WATER STREET	
Bituminous Concrete	3
Brick	2
Portland Cement Concrete	3
WAVERLY STREET	
Missing	4
Portland Cement Concrete	1
WEBCOWET ROAD	
Portland Cement Concrete	4
WEBSTER STREET	
Bituminous Concrete	1
Portland Cement Concrete	12
WELLESLEY ROAD	
Missing	1
WELLINGTON ST	
Portland Cement Concrete	2
WEST STREET	
Missing	2
WESTMINSTER AVE	
Missing	3
Portland Cement Concrete	2
WESTMORELAND AVE	
Missing	3
WHITTEMORE ST	
Brick	2
WILDWOOD AVENUE	
Missing	6
Portland Cement Concrete	15
WILLIAMS STREET	
Bituminous Concrete	2
Missing	11
WILLOW COURT	
Portland Cement Concrete	2
WILSON AVENUE	
Portland Cement Concrete	1
WINCHESTER ROAD	
Bituminous Concrete	1
Missing	6
WINDERMERE AVE	
Missing	3

	Total
WINDSOR STREET	
Portland Cement Concrete	3
WINSLOW STREET	
Missing	4
Portland Cement Concrete	3
WINTER STREET	
Portland Cement Concrete	5
WOLLASTON AVENUE	
Bituminous Concrete	2
Missing	2
Portland Cement Concrete	1
WOODLAND STREET	
Missing	1
Portland Cement Concrete	1
WYMAN STREET	
Portland Cement Concrete	9
WYMAN TERRACE	
Portland Cement Concrete	5

Appendix C – Curb Inventory by Street

Appendix C: Curb Inventory by Street

Street / Curb Type	Total Length (FT)
ABERDEEN ROAD	
Granite	1,418
ACADEMY STREET	
Granite	2,856
None	150
ACTON STREET	
Granite	1,511
ADAMS STREET	
Granite	1,717
ADDISON STREET	
Granite	459
None	1,120
AERIAL STREET	
Granite	1,453
None	24
ALBERMARLE ST	
Granite	805
ALFRED ROAD	
Granite	149
None	983
ALLEN STREET	
Granite	2,302
ALPINE TERRACE	
Granite	573
None	26
ALTON STREET	
Granite	1,193
AMHERST STREET	
Granite	1,072
AMSDEN STREET	
Granite	894
None	1,064
ANDREW STREET	
Granite	732

Street / Curb Type	Total Length (FT)
APACHE TRAIL	
Bituminous Concrete	663
Granite	380
None	541
Other	84
Portland Cement Con	119
APPLETON PLACE	
Granite	1,556
None	280
APPLETON STREET	
Granite	12,819
ARGYLE ROAD	
Granite	1,043
ARNOLD STREET	
Granite	828
None	483
ARROWHEAD LANE	
Granite	1,085
ASHLAND STREET	
Granite	1,409
None	194
AVON PLACE	
Granite	868
None	25
BACON STREET	
Granite	595
None	133
BAILEY ROAD	
Granite	1,653
BAKER ROAD	
Bituminous Concrete	265
None	1,053
BARTLETT AVENUE	
Granite	4,152

	Total Length (FT)
BATES ROAD	
Granite	2,394
BEACON STREET	
Granite	3,060
BELKNAP STREET	
Granite	1,219
BELLINGTON ST	
Granite	2,034
BELTON STREET	
Granite	1,120
BERKELEY STREET	
Bituminous Concrete	1,026
None	26
BEVERLY ROAD	
Granite	300
None	3,813
BLOSSOM STREET	
Bituminous Concrete	1,263
Granite	948
BONAD ROAD	
Granite	996
BOULEVARD ROAD	
Granite	1,389
BOW STREET	
Granite	3,341
BOWDOIN STREET	
Granite	1,073
BRADLEY ROAD	
Bituminous Concrete	532
BRANTWOOD ROAD	
Granite	4,255
BRATTLE STREET	
Granite	3,116
None	129

	Total Length (FT)
BRATTLE TERRACE	
Granite	836
BROADWAY	
Granite	9,167
BROOKDALE ROAD	
Granite	729
BROOKS AVENUE	
Granite	2,569
None	960
Other	411
BROWNING ROAD	
Granite	2,951
BUENA VISTA ROAD	
Granite	607
BURCH STREET	
Bituminous Concrete	775
None	1,173
BURTON STREET	
Granite	735
CANDIA STREET	
Granite	604
None	967
CARL ROAD	
Granite	1,097
None	24
CEDAR AVENUE	
Bituminous Concrete	2,476
CENTRAL STREET	
Granite	1,036
CHANDLER STREET	
Granite	2,322
CHAPMAN STREET	
None	262
Sloped Granite	229

	Total Length (FT)
CHARLES STREET	
Granite	511
None	341
CHARLTON ST	
Granite	1,874
None	25
CHATHAM STREET	
None	1,265
CHEROKEE ROAD	
Granite	1,453
CHESTER STREET	
Granite	2,103
CHESTNUT STREET	
Granite	1,342
CHESTNUT TERRACE	
Granite	881
None	24
CHURCHILL AVENUE	
Granite	601
None	465
Other	1,561
Sloped Granite	272
CLAREMONT AVENUE	
Bituminous Concrete	2,886
Granite	663
None	668
CLEVELAND STREET	
Granite	3,204
CLIFF STREET	
Bituminous Concrete	736
Granite	713
CLYDE TERRACE	
Bituminous Concrete	1,456
COLEMAN ROAD	
Granite	1,034

	Total Length (FT)
COLLEGE AVENUE	
Bituminous Concrete	1,729
Granite	205
None	1,197
COLUMBIA ROAD	
Granite	2,895
COMPTON STREET	
Granite	480
CONCORD TURNPIKE	
Granite	5,070
Sloped Granite	3,338
CORAL STREET	
Granite	523
COREY LANE	
None	379
CORNELL STREET	
Granite	1,071
COUNTRY CLUB DR	
Bituminous Concrete	512
Granite	100
None	712
COURT STREET	
Granite	882
None	235
CRAWFORD STREET	
Granite	1,430
CRESCENT HILL	
Granite	248
None	2,446
CROSBY STREET	
Bituminous Concrete	1,266
Granite	3,723
None	820
CUTTER HILL ROAD	
Bituminous Concrete	809

		Total Length (FT)
CYPRESS ROAD		
	Granite	1,040
DANIELS STREET		
	Granite	563
	None	440
DARTMOUTH STREET		
	Granite	1,068
DAVIS AVENUE		
	Granite	157
	None	1,489
DAVIS ROAD		
	Bituminous Concrete	231
	Granite	418
	None	161
DAY STREET		
	Granite	769
	None	37
DECATUR STREET		
	Granite	2,937
DEVEREAUX STREET		
	Granite	532
	None	596
DICKSON AVENUE		
	Bituminous Concrete	294
	Granite	2,349
	None	646
DODGE STREET		
	Granite	1,169
DOROTHY ROAD		
	Granite	2,389
DOTHAN STREET		
	Granite	1,403
DOW AVENUE		
	Granite	2,969

		Total Length (FT)
DOW AVENUE NORTHERLY		
	Granite	1,907
DRAKE ROAD		
	Granite	648
DRAPER AVENUE		
	Granite	753
	None	680
	Other	90
DUDLEY STREET		
	Granite	2,776
DUNDEE ROAD		
	Granite	1,236
DUNSTER LANE		
	None	157
EASTERN AVENUE		
	Granite	3,139
EDGEHILL ROAD		
	None	2,321
EDITH STREET		
	Bituminous Concrete	620
EDMUND ROAD		
	Granite	1,039
EGERTON ROAD		
	Granite	2,593
ELMORE STREET		
	Granite	499
	None	529
ELWERN ROAD		
	Granite	764
ENDICOTT ROAD		
	Granite	1,299
EPPING STREET		
	Bituminous Concrete	322
	Granite	1,189
	None	278

	Total Length (FT)
EUSTIS STREET	
Bituminous Concrete	1,407
Portland Cement Con	742
EVERETT STREET	
Granite	3,965
None	1,319
EXETER STREET	
Granite	1,497
FABYAN STREET	
Granite	976
FAIRMONT STREET	
Granite	3,252
None	24
FAIRVIEW AVENUE	
Granite	1,535
FALMOUTH ROAD	
Bituminous Concrete	1,712
FALMOUTH ROAD W	
Granite	688
FARMER ROAD	
Granite	753
FARRINGTON ST	
Granite	689
FAYETTE STREET	
Granite	1,419
FIELD ROAD	
Granite	1,377
FISHER ROAD	
Granite	1,329
FLORENCE AVENUE	
Bituminous Concrete	1,348
Granite	5,232
None	1,384
FORDHAM STREET	
Granite	1,081

	Total Length (FT)
FOREST STREET	
Granite	7,190
None	106
Sloped Granite	2,085
FOSTER STREET	
Granite	415
None	1,665
FOUNTAIN ROAD	
Granite	1,590
FOX MEADOW LANE	
Granite	2,308
FRANKLIN STREET	
Granite	5,147
FRAZER ROAD	
Bituminous Concrete	1,016
None	175
FREEMAN STREET	
Granite	1,976
FREMONT STREET	
Granite	1,880
None	539
FROST STREET	
Granite	1,372
GARDNER STREET	
Granite	1,906
None	1,097
GAY STREET	
Bituminous Concrete	99
None	323
GEORGE STREET	
Bituminous Concrete	3,665
Granite	1,395
GLEN AVENUE	
Granite	1,012
None	22

	Total Length (FT)
GLENBURN ROAD	
Granite	2,286
None	197
GLOUCESTER ST	
Granite	3,570
GOLDEN AVENUE	
Granite	217
None	1,303
GORHAM STREET	
Granite	1,135
GOULD ROAD	
None	987
GRAFTON STREET	
Granite	1,956
None	837
GRANTON PARK	
Granite	764
GRAY CIRCLE	
Granite	400
GRAY STREET	
Granite	11,771
GREELEY CIRCLE	
None	1,745
GREENWOOD ROAD	
None	641
GROVE ST PLACE	
Granite	1,052
GROVE STREET	
Granite	2,844
HADLEY COURT	
None	397
HAMLET STREET	
Granite	2,149
HANCOCK STREET	
None	1,409

	Total Length (FT)
HARLOW STREET	
Granite	1,255
None	1,345
HAROLD STREET	
Bituminous Concrete	404
HARTFORD ROAD	
Granite	1,393
HARVARD STREET	
Bituminous Concrete	673
Granite	680
None	39
HATHAWAY CIRCLE	
Granite	369
None	4,100
HAYES STREET	
Granite	1,008
HEARD ROAD	
None	721
HEATH ROAD	
Granite	230
None	534
HEMLOCK STREET	
Bituminous Concrete	438
Granite	1,995
None	1,479
HENDERSON STREET	
Granite	2,120
HENRY STREET	
Granite	1,013
HERBERT ROAD	
Granite	3,638
HIAWATHA LANE	
None	568
HIBBERT STREET	
Granite	2,880

		Total Length (FT)
HIGGINS STREET		
	Granite	768
HIGH HAITH ROAD		
	Bituminous Concrete	837
	Granite	1,539
	None	119
HIGHLAND AVENUE		
	Granite	7,157
HILLCREST STREET		
	Granite	560
	None	221
HILLSDALE ROAD		
	Granite	2,289
HILLSIDE AVENUE		
	Bituminous Concrete	3,484
	Granite	4,404
HILTON STREET		
	Bituminous Concrete	592
	None	359
HODGE ROAD		
	Granite	920
HOMER ROAD		
	Granite	2,043
HOMESTEAD ROAD		
	Granite	409
HOPKINS ROAD		
	Granite	685
	None	637
HOWARD STREET		
	Granite	966
HUNTINGTON ROAD		
	Bituminous Concrete	841
	Granite	960

		Total Length (FT)
HUTCHINSON ROAD		
	Bituminous Concrete	5,639
	Granite	170
INVERNESS ROAD		
	Granite	843
	None	24
IROQUOIS ROAD		
	Granite	939
IRVING STREET		
	Bituminous Concrete	149
	Granite	2,035
	None	193
IVY CIRCLE		
	Granite	712
JASON STREET		
	Granite	7,863
JASON TERRACE		
	None	414
JEAN ROAD		
	Granite	861
JOHNSON ROAD		
	Bituminous Concrete	1,155
JOYCE ROAD		
	Granite	1,479
KEATS ROAD		
	Granite	400
KENSINGTON PARK		
	Granite	2,860
KENSINGTON ROAD		
	Granite	805
KILSYTHE ROAD		
	Granite	1,184
KIMBALL ROAD		
	Granite	1,361
	None	24

	Total Length (FT)
KING STREET	
Granite	541
KIPLING ROAD	
Granite	937
None	27
KNOWLES FARM RD	
Granite	367
LAFAYETTE STREET	
Bituminous Concrete	476
Granite	1,687
LAKE STREET	
Granite	6,858
None	125
LAKEHILL AVENUE	
Granite	1,214
LAKEVIEW ROAD	
None	1,086
LANARK ROAD	
Granite	863
LANCASTER ROAD	
Granite	1,657
LANGLEY ROAD	
Granite	896
LANSDOWNE ROAD	
Granite	817
LANTERN LANE	
Bituminous Concrete	403
Granite	244
None	1,675
Other	435
LAUREL STREET	
Bituminous Concrete	817
LAWRENCE LANE	
Bituminous Concrete	322
None	641

	Total Length (FT)
LEHIGH STREET	
Granite	417
None	29
LENNON ROAD	
Bituminous Concrete	737
Granite	986
None	478
LEWIS AVENUE	
Granite	1,431
LINCOLN STREET	
Granite	718
LINDEN STREET	
Granite	420
None	1,237
LINWOOD STREET	
Granite	1,359
LITTLEJOHN ST	
Granite	776
None	398
LOCKE STREET	
Granite	797
None	24
LOCKELAND AVE	
Granite	2,211
LOMBARD ROAD	
Granite	159
None	777
LOMBARD TERRACE	
Granite	157
None	1,471
LONGFELLOW ROAD	
Granite	1,786
LONGMEADOW ROAD	
Granite	2,423

	Total Length (FT)
LORNE ROAD	
Granite	551
LORRAINE TERRACE	
Granite	1,319
LOWELL ST PLACE	
Granite	597
None	28
LOWELL STREET	
Granite	7,164
MAGNOLIA STREET	
Granite	2,125
MAPLE STREET	
Granite	1,379
MARATHON STREET	
Granite	1,914
None	1,359
MARGARET STREET	
Granite	806
None	1,289
MARION CIRCLE	
None	481
MARION ROAD	
None	1,472
MARRIGAN STREET	
Granite	708
MARY STREET	
Granite	3,469
MASSACHUSETTS	
Granite	33,544
MASSACHUSETTS AVE (WB)	
Granite	1,886
None	273
MAYNARD STREET	
Granite	1,012
None	931

	Total Length (FT)
MEAD ROAD	
Bituminous Concrete	209
Granite	139
None	736
MEDFORD ST	
Granite	5,276
MELANIE LANE	
Bituminous Concrete	979
Granite	78
MELROSE STREET	
Granite	2,861
MELVIN ROAD	
Granite	187
None	703
MEMORIAL WAY	
Granite	754
MENOTOMY ROAD	
Granite	2,710
MENOTOMY ROCKS	
None	780
MICHAEL STREET	
Granite	1,267
MILL BROOK DRIVE	
Granite	775
Sloped Granite	1,099
MILL LANE	
Granite	823
MILL STREET	
Granite	1,663
MILTON STREET	
Granite	2,970
MOCCASIN PATH	
Bituminous Concrete	97
Granite	992

Street / Curb Type	Total Length (FT)
MODENA STREET	
Granite	389
MOHAWK ROAD	
Granite	422
None	838
MONTAGUE STREET	
Granite	639
MORNINGSIDE DR	
Bituminous Concrete	2,325
Granite	164
None	1,184
MOTT STREET	
Bituminous Concrete	1,441
None	1,454
MOULTON ROAD	
Granite	1,518
MOUNTAIN AVENUE	
Bituminous Concrete	278
Granite	484
None	2,834
MT VERNON STREET	
Granite	5,127
MYSTIC LAKE DR	
Granite	1,316
MYSTIC ST (NB)	
Granite	1,655
MYSTIC STREET	
Granite	14,632
MYSTIC STREET (SB)	
Granite	334
NEWCOMB STREET	
Granite	1,915
NEWLAND ROAD	
Granite	2,309
Sloped Granite	1,434

Street / Curb Type	Total Length (FT)
NEWMAN WAY	
Granite	1,226
NEWPORT STREET	
Granite	5,760
NEWTON ROAD	
Granite	801
NICOD STREET	
Granite	339
None	1,389
NORCROSS STREET	
Granite	1,478
NORFOLK ROAD	
Granite	2,188
NORTH UNION ST	
Granite	2,258
None	1,407
NOURSE ROAD	
Granite	681
None	24
OAK HILL DRIVE	
Bituminous Concrete	2,993
OAK KNOLL	
Granite	706
OAKLAND AVENUE	
Granite	7,249
None	929
OAKLEDGE STREET	
Bituminous Concrete	658
OLD COLONY ROAD	
Granite	2,611
OLD MIDDLESEX	
Granite	2,223
None	166

		Total Length (FT)
OLD MYSTIC ST		
	Bituminous Concrete	2,154
	Granite	1,856
OLD SPRING ST		
	None	971
OLDHAM ROAD		
	None	1,116
ORCHARD TERRACE		
	None	670
ORIENT AVENUE		
	Granite	491
ORVIS RD (SB)		
	Granite	1,714
ORVIS ROAD (NB)		
	Granite	1,296
OSBORNE ROAD		
	Granite	554
OSCEOLA PATH		
	None	613
OTTAWA ROAD		
	Granite	1,053
	None	72
OVERLOOK ROAD		
	Bituminous Concrete	721
	Granite	1,905
	None	607
	Sloped Granite	1,469
OXFORD STREET		
	Granite	2,909
PALMER STREET		
	Granite	5,232
PARALLEL STREET		
	Granite	839
PARK AVE		
	Granite	5,718

		Total Length (FT)
PARK AVENUE		
	Granite	4,830
PARK AVENUE EXT		
	Granite	4,821
PARK CIRCLE		
	Bituminous Concrete	1,040
	Granite	1,048
PARK STREET		
	Granite	2,925
PARKER STREET		
	Granite	769
PATRICK STREET		
	None	814
PAUL REVERE ROAD		
	Granite	4,413
PAWNEE DRIVE		
	None	1,233
PECK AVENUE		
	None	693
PEIRCE STREET		
	Granite	695
	None	639
PELHAM TERRACE		
	None	676
PETER TUFTS ROAD		
	Granite	1,137
PHEASANT AVENUE		
	Granite	2,383
PHILIPS STREET		
	Granite	1,191
PIEDMONT STREET		
	Granite	331
	None	205

	Total Length (FT)
PINE RIDGE ROAD	
Bituminous Concrete	1,092
Granite	1,344
PINE STREET	
Bituminous Concrete	324
Granite	1,078
PLEASANT STREET	
Granite	8,410
Portland Cement Con	49
Sloped Granite	38
PLEASANT VIEW RD	
Granite	87
None	1,992
PLYMOUTH STREET	
Granite	646
POND LANE	
Granite	1,179
PONDVIEW ROAD	
Granite	101
None	1,056
PRESCOTT STREET	
Granite	1,052
PROSPECT AVENUE	
None	636
PURCELL ROAD	
Granite	412
None	405
QUINCY STREET	
Granite	2,657
QUINN ROAD	
None	599
RADCLIFF ROAD	
Bituminous Concrete	634

	Total Length (FT)
RALEIGH STREET	
Granite	216
None	1,832
RANDOLPH STREET	
Granite	1,747
RANGELEY ROAD	
Granite	810
None	379
RAVINE STREET	
Granite	771
RAWSON ROAD	
Granite	3,320
RENFREW STREET	
Bituminous Concrete	739
Granite	3,620
RESERVOIR ROAD	
Granite	461
None	24
REVERE STREET	
Granite	740
RHINECLIFF ST	
Bituminous Concrete	5,249
Granite	2,055
RICHARDSON AVE	
Granite	815
RICHFIELD ROAD	
Bituminous Concrete	885
Granite	3,373
RIDGE STREET	
Bituminous Concrete	2,252
Granite	1,751
None	7,888
Portland Cement Con	314
RIVER STREET	
Granite	2,925

	Total Length (FT)
ROBBINS ROAD	
Granite	2,646
ROCKMONT ROAD	
None	1,573
RONALD ROAD	
None	2,514
Sloped Granite	326
RUBLEE STREET	
Granite	2,676
None	365
RUSSELL STREET	
Granite	1,539
RUSSELL TERRACE	
Granite	793
SAGAMORE ROAD	
Granite	98
SARATOGA ROAD	
Granite	542
SAWIN STREET	
Granite	459
SCHOOL STREET	
Granite	2,749
SCHOULER COURT	
Granite	582
None	24
Sloped Granite	196
SCITUATE STREET	
Granite	4,681
SEMINOLE AVENUE	
Granite	241
None	272
SHAWNEE ROAD	
Granite	1,164

	Total Length (FT)
SHERBORN STREET	
Granite	884
None	337
SILK STREET	
Granite	1,675
None	140
SLEEPY HOLLOW LA	
Granite	126
None	540
SORENSON COURT	
None	427
SPRING AVENUE	
Granite	443
SPRING STREET	
Bituminous Concrete	2,619
Granite	2,549
STONE ROAD	
Bituminous Concrete	462
None	736
STOWECROFT ROAD	
Granite	366
None	2,380
SUMMER STREET	
Granite	19,585
None	627
SUMMIT STREET	
Granite	842
SUNNYSIDE AVENUE	
Granite	1,257
None	2,617
SUNSET ROAD	
Granite	3,301
None	81
SURRY ROAD	
Granite	1,055

Street / Curb Type	Total Length (FT)
SUTHERLAND ROAD	
Granite	1,501
None	42
SWAN PLACE	
Bituminous Concrete	245
Granite	940
None	21
SWAN STREET	
Granite	524
SYLVIA STREET	
Granite	2,734
None	164
TANAGER STREET	
Bituminous Concrete	639
Granite	1,200
TEEL STREET	
Granite	2,007
TEMPLE STREET	
Granite	1,800
TERESA CIRCLE	
Granite	1,525
None	301
THESDA STREET	
Granite	475
THORNDIKE STREET	
Granite	3,153
TOMAHAWK ROAD	
Granite	519
None	1,942
TOWER ROAD	
None	1,278
TROWBRIDGE ST	
Granite	2,047

Street / Curb Type	Total Length (FT)
TUFTS STREET	
Granite	2,418
None	125
TWIN CIRCLE DR	
None	1,220
UDINE STREET	
Granite	1,811
None	48
UNIVERSITY ROAD	
Granite	934
UPLAND ROAD	
Bituminous Concrete	912
UPLAND ROAD WEST	
Bituminous Concrete	832
Granite	954
VALENTINE ROAD	
Bituminous Concrete	3,467
Granite	226
VARNUM STREET	
Granite	3,284
None	24
VENNER ROAD	
Granite	1,450
VICTORIA ROAD	
Granite	1,340
VIRGINIA ROAD	
None	1,518
W. COURT TERRACE	
Granite	431
None	45
WACHUSETT AVENUE	
Granite	3,318
None	2,797

	Total Length (FT)
WADSWORTH ROAD	
Granite	800
Sloped Granite	1,650
WALDO ROAD	
Granite	822
None	1,100
WALNUT COURT	
Granite	541
None	25
WALNUT STREET	
Granite	2,628
WALNUT TERRACE	
Bituminous Concrete	666
Granite	560
WARREN STREET	
Granite	5,177
WASHINGTON ST	
Bituminous Concrete	1,597
Granite	5,300
None	474
WATER STREET	
Granite	1,327
None	86
WAVERLY STREET	
Bituminous Concrete	2,726
Granite	1,481
WEBCOWET ROAD	
Granite	171
None	1,910
WEBSTER STREET	
Granite	4,329
None	125
WELLESLEY ROAD	
None	924

	Total Length (FT)
WELLINGTON ST	
Granite	1,376
None	290
WEST STREET	
Granite	906
WESTMINSTER AVE	
Bituminous Concrete	398
Granite	2,191
None	1,940
WESTMORELAND AVE	
Granite	552
None	628
WHEATON ROAD	
None	844
WHEELER LANE	
Granite	419
WHITE STREET	
Granite	556
WHITTEMORE ST	
Granite	966
WIGWAM CIRCLE	
Bituminous Concrete	204
None	307
WILBUR AVENUE	
None	2,554
WILDWOOD AVENUE	
Granite	3,259
WILLIAMS STREET	
Granite	2,844
None	435
WINCHESTER ROAD	
Bituminous Concrete	403
Granite	1,842
None	1,165

		Total Length (FT)
WINDERMERE AVE		
	Granite	900
WINDMILL LANE		
	Bituminous Concrete	275
	None	256
WINDSOR STREET		
	None	2,035
WINSLOW STREET		
	Bituminous Concrete	150
	Granite	583
WINTER STREET		
	Granite	3,115
WOLLASTON AVENUE		
	Granite	3,351
	None	3,142
WOODLAND STREET		
	Granite	1,070
WOODSIDE LANE		
	Granite	3,417
WRIGHT STREET		
	Granite	2,380
	None	545
WYMAN STREET		
	Granite	1,829
	None	303
WYMAN TERRACE		
	Granite	1,458
	None	83
YALE ROAD		
	None	1,008
YERXA ROAD		
	Bituminous Concrete	198
	None	2,057
	Portland Cement Con	145

Appendix D – Tree/Sidewalk Impact Inventory by Street

Appendix D: Tree/Sidewalk Impact Report

	Total
ACADEMY STREET	
Medium	10
Low	2
ACTON STREET	
Medium	2
ADDISON STREET	
High	6
Low	6
Medium	2
AERIAL STREET	
Medium	6
ALBERMARLE ST	
Low	5
ALFRED ROAD	
Medium	4
High	3
Low	1
ALLEN STREET	
Medium	3
ALTON STREET	
Medium	1
High	1
Low	1
AMHERST STREET	
Medium	2
AMSDEN STREET	
Medium	3
ANDREW STREET	
Medium	1

	Total
APPLETON STREET	
Medium	22
High	3
ARGYLE ROAD	
Medium	3
ARNOLD STREET	
Medium	6
High	1
ASHLAND STREET	
Medium	2
BAILEY ROAD	
Medium	3
Low	2
BARTLETT AVENUE	
Low	11
Medium	10
	2
High	1
BATES ROAD	
Medium	2
Low	1
BEACON STREET	
Low	1
BELLINGTON ST	
Medium	12
Low	2
High	1
BELTON STREET	
High	1

	Total
BERKELEY STREET	
Medium	1
BEVERLY ROAD	
Medium	14
High	5
BLOSSOM STREET	
Medium	7
BONAD ROAD	
Low	8
Medium	1
BOULEVARD ROAD	
Medium	2
BOW STREET	
Medium	12
BRADLEY ROAD	
Medium	3
BRATTLE STREET	
Medium	6
Low	1
BRATTLE TERRACE	
Medium	2
BROADWAY	
Medium	7
High	1
Low	1
BROOKDALE ROAD	
Medium	2
BROOKS AVENUE	
High	1
Low	1
BUENA VISTA ROAD	
Medium	1

	Total
BURCH STREET	
Medium	4
Low	1
BURTON STREET	
Medium	2
Low	1
CAMPBELL ROAD	
Medium	3
High	2
CARL ROAD	
Medium	1
CEDAR AVENUE	
High	5
Medium	4
Low	2
CENTRAL STREET	
High	3
Medium	1
CHANDLER STREET	
Low	1
CHATHAM STREET	
Medium	4
High	1
CHESTER STREET	
Low	8
Medium	7
High	1
CHURCHILL AVENUE	
Low	9
Medium	8
High	2

	Total
CLAREMONT AVENUE	
Medium	11
High	1
CLIFF STREET	
High	2
Medium	2
COLEMAN ROAD	
Low	3
Medium	1
COLLEGE AVENUE	
Medium	5
High	2
COLUMBIA ROAD	
Medium	11
High	1
COMPTON STREET	
Medium	1
CRAWFORD STREET	
Medium	8
High	2
CRESCENT HILL	
Medium	3
High	1
CROSBY STREET	
Medium	10
CUTTER HILL ROAD	
Medium	2
CYPRESS ROAD	
Medium	6
High	1

	Total
DANIELS STREET	
Low	2
Medium	1
DARTMOUTH STREET	
Medium	2
DAVIS AVENUE	
Medium	7
High	1
DECATUR STREET	
Medium	2
DEVEREAUX STREET	
Medium	2
DOROTHY ROAD	
Medium	5
High	1
Low	1
DOW AVENUE	
Medium	1
DOW AVENUE NORTHERLY	
Medium	1
DRAPER AVENUE	
Medium	9
High	1
DUDLEY STREET	
Medium	3
High	2
DUNDEE ROAD	
Medium	1
EASTERN AVENUE	
Medium	4
High	3
Low	3

	Total
EDGEHILL ROAD	
Medium	7
Low	4
High	1
EDITH STREET	
Low	1
EDMUND ROAD	
Medium	1
EGERTON ROAD	
Medium	5
High	2
ELMORE STREET	
Medium	3
ENDICOTT ROAD	
Medium	4
Low	3
EUSTIS STREET	
High	8
Medium	6
Low	2
EVERETT STREET	
Medium	13
Low	5
High	1
EXETER STREET	
Medium	3
Low	2
FAIRMONT STREET	
Medium	4
Low	2

	Total
FAIRVIEW AVENUE	
Medium	8
High	1
FALMOUTH ROAD	
High	2
Medium	2
FALMOUTH ROAD W	
Medium	4
FARMER ROAD	
Medium	1
FARRINGTON ST	
Medium	9
High	1
FAYETTE STREET	
Medium	6
High	3
Low	1
FIELD ROAD	
Low	1
FISHER ROAD	
Medium	7
Low	6
High	1
FLORENCE AVENUE	
Medium	9
High	3
Low	1
FORDHAM STREET	
Medium	2
FOREST STREET	
Medium	6
High	1

	Total
FOSTER STREET	
Medium	3
Low	1
FRANKLIN STREET	
Medium	4
Low	3
High	1
FREEMAN STREET	
Medium	7
FREMONT STREET	
Medium	5
High	1
FROST STREET	
Medium	3
High	1
GARDNER STREET	
High	2
GEORGE STREET	
Medium	10
High	4
GLEN AVENUE	
Medium	3
GLENBURN ROAD	
Medium	13
High	3
GLOUCESTER ST	
Low	10
Medium	3
High	2
GOULD ROAD	
Medium	2

	Total
GRAFTON STREET	
Medium	8
Low	2
GRAY STREET	
Medium	32
Low	21
High	12
HADLEY COURT	
Medium	2
High	1
HARLOW STREET	
Medium	4
Low	1
HARVARD STREET	
Medium	6
HAYES STREET	
Medium	2
HEARD ROAD	
Medium	6
HEATH ROAD	
Medium	2
High	1
HEMLOCK STREET	
Medium	4
HENDERSON STREET	
Medium	5
HERBERT ROAD	
Medium	9
Low	1
HIBBERT STREET	
Medium	2
High	1

	Total
HIGH HAITH ROAD	
Low	10
	3
Medium	2
High	1
HIGHLAND AVENUE	
Low	17
Medium	8
High	1
HILLCREST STREET	
Medium	1
HILLSDALE ROAD	
Medium	3
HILLSIDE AVENUE	
Medium	15
High	1
Low	1
HILTON STREET	
Medium	4
High	3
HOPKINS ROAD	
Medium	3
Low	1
High	1
HUNTINGTON ROAD	
Medium	6
INVERNESS ROAD	
Medium	1
IROQUOIS ROAD	
Low	7

	Total
IRVING STREET	
Medium	5
High	2
Low	1
JASON STREET	
Medium	22
Low	13
High	7
JOHNSON ROAD	
Medium	4
Low	2
JOYCE ROAD	
Medium	8
High	1
KENSINGTON PARK	
Low	1
KILSYTHE ROAD	
Medium	4
High	1
KIMBALL ROAD	
Medium	7
High	2
LAFAYETTE STREET	
Low	3
Medium	1
LAKE STREET	
Medium	16
Low	3
LAKEHILL AVENUE	
Medium	3

	Total
LAKEVIEW ROAD	
Medium	6
High	2
LANCASTER ROAD	
Medium	5
High	2
Low	1
LANGLEY ROAD	
Medium	5
High	2
LAUREL STREET	
High	1
Medium	1
LENNON ROAD	
Medium	2
LINCOLN STREET	
Medium	3
High	2
Low	2
LINDEN STREET	
Medium	1
LINWOOD STREET	
Medium	1
LITTLEJOHN ST	
Medium	4
Low	1
LOCKELAND AVE	
Low	8
Medium	2
High	1

	Total
LOMBARD ROAD	
Medium	3
High	1
LONGFELLOW ROAD	
Low	3
Medium	2
LORNE ROAD	
High	1
LOWELL ST PLACE	
Medium	1
LOWELL STREET	
Medium	16
MAGNOLIA STREET	
Low	2
High	1
Medium	1
MAPLE STREET	
Medium	4
High	1
Low	1
MARATHON STREET	
Medium	6
Low	4
MARGARET STREET	
Medium	2
MARION CIRCLE	
Medium	3
High	1
MARION ROAD	
Medium	2
MARRIGAN STREET	
Medium	1

	Total
MARY STREET	
Medium	11
High	1
Low	1
MASSACHUSETTS	
Low	10
Medium	9
High	2
MAYNARD STREET	
Medium	2
Low	1
MEDFORD ST	
Low	6
Medium	4
MELROSE STREET	
Medium	5
MENOTOMY ROAD	
Low	5
MICHAEL STREET	
Medium	6
Low	1
MILL STREET	
High	1
Medium	1
MILTON STREET	
Medium	3
Low	1
High	1
MORNINGSIDE DR	
Medium	9
High	1

	Total
MOTT STREET	
Medium	11
High	1
MOULTON ROAD	
Low	4
Medium	3
MOUNTAIN AVENUE	
Medium	2
High	1
MT VERNON STREET	
Low	21
Medium	7
High	5
MYSTIC LAKE DR	
Medium	3
MYSTIC STREET	
Medium	10
Low	2
High	1
NEWCOMB STREET	
Medium	1
NEWLAND ROAD	
Medium	5
High	2
NEWMAN WAY	
Low	5
Medium	2
High	1
NEWPORT STREET	
Low	25
Medium	4
High	1

	Total
NEWTON ROAD	
Medium	2
NORFOLK ROAD	
Low	1
Medium	1
NOURSE ROAD	
Medium	5
OAK HILL DRIVE	
Medium	10
High	4
OAK KNOLL	
Medium	2
High	1
OAKLAND AVENUE	
Medium	1
OAKLEDGE STREET	
Medium	3
OLD MYSTIC ST	
Medium	1
ORVIS RD (SB)	
Medium	1
OTTAWA ROAD	
Low	5
Medium	1
OVERLOOK ROAD	
Medium	11
High	3
OXFORD STREET	
Medium	3
Low	3

	Total
PALMER STREET	
Medium	7
Low	1
PARALLEL STREET	
Medium	1
Low	1
PARK AVE	
Medium	9
High	2
Low	1
PARK AVENUE	
Medium	6
High	4
Low	2
PARK AVENUE EXT	
Medium	9
High	1
PARK CIRCLE	
Low	1
Medium	1
PARK STREET	
Low	1
Medium	1
PARKER STREET	
Medium	4
PAUL REVERE ROAD	
Medium	4
High	4
Low	1
PETER TUFTS ROAD	
Medium	6

	Total
PHEASANT AVENUE	
High	2
Medium	1
PHILIPS STREET	
Medium	1
PINE RIDGE ROAD	
Low	3
Medium	1
PINE STREET	
Medium	6
High	1
PLEASANT STREET	
Medium	24
Low	17
High	3
PLEASANT VIEW RD	
High	3
Medium	3
PLYMOUTH STREET	
Low	3
Medium	1
PONDVIEW ROAD	
Medium	4
PRESCOTT STREET	
Medium	4
QUINCY STREET	
Medium	8
High	1
Low	1
RADCLIFF ROAD	
Medium	1

	Total
RANDOLPH STREET	
Medium	4
RANGELEY ROAD	
Medium	1
RAWSON ROAD	
Medium	6
RENFREW STREET	
Medium	4
RESERVOIR ROAD	
Medium	5
REVERE STREET	
Medium	1
RHINECLIFF ST	
Medium	15
High	3
RICHARDSON AVE	
Medium	1
RICHFIELD ROAD	
Medium	13
High	1
RIDGE STREET	
Medium	7
High	1
Low	1
RIVER STREET	
Medium	3
ROBBINS ROAD	
Medium	5
High	2
ROCKMONT ROAD	
Medium	7
High	2

	Total
RONALD ROAD	
Medium	4
RUBLEE STREET	
Medium	2
RUSSELL STREET	
Medium	2
Low	1
SARATOGA ROAD	
Medium	5
SCHOOL STREET	
Medium	1
SCITUATE STREET	
Low	14
Medium	5
SHAWNEE ROAD	
Low	7
High	1
SHERBORN STREET	
High	1
Medium	1
SILK STREET	
Medium	3
High	2
SPRING AVENUE	
Medium	1
SPRING STREET	
Medium	2
High	1
STOWECROFT ROAD	
Medium	3
High	1

	Total
SUMMER STREET	
Medium	4
SUNNYSIDE AVENUE	
Medium	9
High	5
Low	3
SUNSET ROAD	
Medium	10
SUTHERLAND ROAD	
Medium	5
Low	1
TANAGER STREET	
Medium	2
Low	1
TEEL STREET	
Medium	3
High	1
TEMPLE STREET	
Low	19
Medium	5
THORNDIKE STREET	
Medium	5
Low	2
High	1
TROWBRIDGE ST	
Medium	4
Low	1
TUFTS STREET	
Medium	3
UDINE STREET	
Medium	1

	Total
UNIVERSITY ROAD	
Medium	4
Low	3
High	1
UPLAND ROAD	
Medium	1
UPLAND ROAD WEST	
High	2
Medium	2
VALENTINE ROAD	
Medium	11
High	4
VARNUM STREET	
Medium	4
Low	1
VENNER ROAD	
Medium	6
High	2
VICTORIA ROAD	
Medium	2
Low	2
VIRGINIA ROAD	
Medium	3
High	3
W. COURT TERRACE	
Medium	7
WACHUSETT AVENUE	
Medium	26
High	1
WADSWORTH ROAD	
Medium	1

	Total
WALDO ROAD	
Medium	4
WALNUT TERRACE	
Medium	3
High	2
Low	1
WARREN STREET	
High	6
Medium	6
Low	1
WASHINGTON ST	
High	1
Medium	1
WATER STREET	
Medium	3
Low	1
High	1
WAVERLY STREET	
Medium	17
High	9
WEBCOWET ROAD	
Medium	3
High	1
WEBSTER STREET	
Medium	5
Low	1
WEST STREET	
Medium	6
WESTMINSTER AVE	
Medium	6

	Total
WESTMORELAND AVE	
Medium	5
High	1
WILDWOOD AVENUE	
Low	18
Medium	8
WILLIAMS STREET	
Medium	8
High	6
WINCHESTER ROAD	
Medium	5
Low	1
WINDERMERE AVE	
Medium	8
High	2
Low	2
WINDSOR STREET	
Low	2
Medium	2
WOLLASTON AVENUE	
Medium	10
High	3
WOODLAND STREET	
Low	5
Medium	1
High	1
WYMAN STREET	
Medium	5
High	1
WYMAN TERRACE	
Medium	2
High	1

Reference 8

www.vhb.com

Community Preservation Act Committee
Town of Arlington

CPA Funding – FY2024 Final Application

One (1) electronic copy of the completed application must be submitted to the CPAC **on December 19, 2022** in order to be considered for advancement to the final application stage, with the electronic copy sent to jwayman@town.arlington.ma.us

Applications will be date stamped and assigned control numbers in the order that the hard copies are received. This PDF form may be completed on a computer using Adobe Reader.

1. General Information

Project Title: Town Hall Envelope - Phase 1 (Clock Tower)

Applicant/Contact: James Feeney

Organization: Town of Arlington

Mailing Address: 730 Mass Ave.

Telephone: (781) 316-3017 E-mail: jfeeney@town.arlington.ma.us

2. CPA Eligibility (refer to the chart on page A-4)

CPA Category (select one):

☐ Community Housing ▣ Historic Preservation ☐ Open Space ☐ Recreation

CPA Purpose (select one):

☐ Acquisition ☐ Creation ▣ Preservation ☐ Support ☐ Rehabilitation & Restoration

3. Budget

Amount Requested: $385,000 Total Project Cost: ~$10M

Signature____________________ Date 12/16/2022

Please answer and document all questions on the following page

PROJECT DESCRIPTION: Attach answers to the following questions. Applications will be returned as incomplete if all requested information is not provided. Include supporting materials as necessary.

1. **Goals**: What are the goals of the proposed project?
2. **Community Need**: Why is the project needed? Does it address needs identified in existing Town plans? If so, please specify.
3. **Community Support**: What is the nature and level of support for this project? Include letters of support and any petitions.
4. **Project Documentation**: Attach any applicable engineering plans, architectural drawings, site plans, photographs, any other renderings, relevant studies or material.
5. **Timeline**: What is the schedule for project implementation, including a timeline for all critical milestones?
6. **Credentials**: How will the experience of the applicant contribute to the success of this project?
7. **Budget**: What is the total budget for the project and how will funds be sourced and spent? All items of expenditure must be clearly identified. Distinguish between hard and soft costs and contingencies. (NOTE: CPA funds may not be used for maintenance.)
8. **Other Funding**: What additional funding sources are available, committed, or under consideration? Include commitment letters, if available, and describe any other attempts to secure funding for this project.
9. **Maintenance**: If ongoing maintenance is required for your project, how will it be funded?
10. **Impact on Town Budget**: What, if any, potential secondary effects will your proposed project have on the Town's Operating Budget? Are there any capital projects that rely on the successful completion of your project?

ADDITIONAL INFORMATION: Provide the following additional information, as applicable.

1. **Control of Site**: Documentation that you have control over the site, such as a Purchase and Sales Agreement, option or deed. If the applicant does not have site control, explain what communications have occurred with the bodies that have control and how public benefits will be protected in perpetuity or otherwise.
2. **Deed Restrictions**: In order for funding to be distributed, an appropriate deed restriction, meeting the requirements of Chapter 184 of Mass General Laws pursuant to section 12 of the Community Preservation Act, must be filed with the CPAC. Provide a copy of the actual or proposed restrictions that will apply to this project.
3. **Acquisitions**: For acquisition projects, attach appraisals and agreements if available. Attach a copy of the deed.

4. **Feasibility**: Provide a list of all further actions or steps that will be required for completion of the project, such as environmental assessments, zoning approvals, and any other known barriers to moving forward.
5. **Hazardous Materials**: Provide evidence that the proposed project site is free of hazardous materials or there is a plan for remediation in place.
6. **Permitting**: Provide evidence that the project does not violate any zoning ordinances, covenants, restrictions or other laws or regulations. What permits, if any, are needed for this project? Provide the expected date of receipt for necessary permits, and copies of any permits already acquired.
7. **Environmental Concerns**: Identify all known wetlands, floodplains, and/or any natural resource limitation that occur within the boundaries of your submission.
8. **Professional Standards**: Evidence that appropriate professional standards will be followed if construction, restoration or rehabilitation is proposed. Evidence that the applicant and the project team have the proven or potential capacity to conduct the scope and scale of the proposed project, as evidenced by project leaders with appropriate qualifications and technical experience or access to technical expertise.
9. **Further Attachments**: Assessor's map showing location of the project.

Five-Year Community Preservation Act Forecast *(New for FY2023)*

To help the committee collaborate with other Town funding mechanisms, the committee is looking to build out a five-year revenue and expenditure forecast.

1. Please list likely funding requests to the CPA Committee for FY2025-2028

Project Title	CPA Category*	Dollar Amount of Request per Fiscal Year			
		FY2025	FY2026	FY2027	FY2028
Town Hall Envelope -Phase II	Historic Preservation	~$500k	~$500k	~$500k	~$500k

**(Open Space/Recreation, Historic Resources, Community Housing)*

REMINDER: Projects financed with CPA funds must comply with all applicable state and municipal requirements, including the state procurement law, which requires special procedures for the selection of products, vendors, services, and consultants. Project sponsors will be required to meet with Arlington's Town Manager before the Town enters into any contracts or issues any purchase orders. However, this requirement can be waived if adherence to procurement procedures will be overseen by a Town Department Head or other MCPPO certified third party.

EXHIBIT 1
COMMUNITY PRESERVATION FUND ALLOWABLE SPENDING PURPOSES (G.L.c.44B,§5)

	OPEN SPACE	HISTORIC RESOURCES	RECREATIONAL LAND	COMMUNITY HOUSING
DEFINITIONS (G.L. c. 44B, § 2)	**Land to protect existing and future well fields, aquifers and recharge areas, watershed land, agricultural land, grasslands, fields, forest land, fresh and salt water marshes and other wetlands, ocean, river, stream, lake and pond frontage, beaches, dunes and other coastal lands, lands to protect scenic vistas, land for wildlife or nature preserve and land for recreational use**	**Building, structure, vessel, real property, document or artifact listed on the state register of historic places or determined by the local historic preservation commission to be significant in the history, archeology, architecture or culture of the city or town**	**Land for active or passive recreational use including, but not limited to, the use of land for community gardens, trails, and noncommercial youth and adult sports, and the use of land as a park, playground or athletic field** **Does <u>not</u> include horse or dog racing or the use of land for a stadium, gymnasium or similar structure.**	**Housing for low and moderate income individuals and families, including low or moderate income seniors** **Moderate income is less than 100%, and low income is less than 80%, of US HUD Area Wide Median Income**
ACQUISITION Obtain property interest by gift, purchase, devise, grant, rental, rental purchase, lease or otherwise. Only includes eminent domain taking as provided by G.L. c. 44B	**Yes**	**Yes**	**Yes**	**Yes**
CREATION To bring into being or cause to exist. *Seideman v. City of Newton*, 452 Mass. 472 (2008)	**Yes**		**Yes**	**Yes**
PRESERVATION Protect personal or real property from injury, harm or destruction	**Yes**	**Yes**	**Yes**	**Yes**
SUPPORT Provide grants, loans, rental assistance, security deposits, interest-rate write downs or other forms of assistance directly to individuals and families who are eligible for community housing, or to entity that owns, operates or manages such housing, for the purpose of making housing affordable				**Yes, includes funding for community's affordable housing trust**
REHABILITATION AND RESTORATION Make capital improvements, or extraordinary repairs to make assets functional for intended use, including improvements to comply with federal, state or local building or access codes or federal standards for rehabilitation of historic properties	**Yes if acquired or created with CP funds**	**Yes**	**Yes**	**Yes if acquired or created with CP funds**

The Robbins Memorial Town Hall (MHC ID ARL.604) as designed by Richard Clipston Sturgis was built in 1912 and remains Arlington's center of civic activity. This prominent and architecturally significant building was a donation of the will of Winfield Robbins in memory of his father Amos, and contains many ornate features. It is owned and operated by the Town of Arlington, and protected by a preservation restriction.

After over 100 years of service, the building is in need of reinvestment following decades of deferred maintenance. The entirety of the building envelope, including the limestone facade, terra cotta Clock Tower, wooden windows and doors and various roofing membranes need repair and/or replacement.

The Town of Arlington retained Design Associates to conduct a preliminary assessment and prepare a preservation plan for Town Hall. Principal Patrick Guthrie (who prepared a similar report for the Jason Russell House) led a team of specialized sub-consultants, including Silman Associates, Fragale Building Corporation, Dutelle Roofers and Metal Craftsmen, as well as Ivan Myjer/Building & Monument Conservation. While the final report is still being prepared, and will be available with the final project application if advanced, preliminary findings reveal dire conditions related to the Clock Tower.

The Clock Tower is a somewhat independent structure and section of the 1913 building, clad in terra cotta as opposed to Indiana limestone. Unfortunately, the embedded structural steel members are rusted and deteriorated causing visible structural sagging. Concrete encasements and deck are spalling, cracked and failing. The terra cotta elements are cracked and exhibiting other signs of advanced deterioration. With the amount of cracking that is readily visible, experts believe the possibility of fragment detachment will reach the point of being a life safety issue.

The continued water penetration through failed terra cotta and concrete assemblies is subjecting the interior of the building to ongoing water damage in the Lyons Hearing Room. This is visible in the ceiling, and at times enters the ceiling mounted light fixtures. Regrettably, some water damage has reached the gilded cast plaster design element bordering the ceiling, and is on route to the irreplaceable chestnut paneling. The water intrusion is worsening rapidly.

Phase 1 of the Town Hall Envelope Restoration proposes to first conduct a comprehensive 3D laser scan of the Clock Tower to effectively capture the shape and dimension of the structure and its various elements. The Town of Arlington is pursuing this effort currently, hoping to conclude initial efforts in the coming weeks prior to tarping the Clock Tower as water intrusion is rapidly worsening. Further scanning of the more ornate items would be done off-site after disassembly. During a later phase, these scans would be used to design and fabricate new pre-cast elements off-site for future restoration. After scanning and cataloging the structure, it is necessary to deconstruct the structure, salvaging clock components and other elements where possible. Upon the safe removal of the Clock Tower, the opening into the attic space of the building would receive any necessary infill framing, flashing and be roofed over to preserve the interior of the building and the structural steel members to remain from further water damage and irreparable harm.

Thinking ahead, while the loss of the cupola will be dramatic, the building will remain stable until a funding plan is established to preserve the remainder of the envelope. Of course, the reconstruction of the Clock Tower, abatement and restoration of the windows, repair and reflashing the balustrade, and cleaning and repointing of the limestone facade, and roof replacement could be phased over a number of years, there are a number of strong arguments to be made for pursuing a single, holistic project – chief among them is the quality of the finished product and ensuring consistent treatment of the elements across the building. Having a number of different low-bid contractors work on the envelope via multiple successive bids will necessarily impact mortar color and tooling, appearance and manufacture of pre-cast elements, window restoration activities, workmanship, and other elements, inevitably creating an inconsistent treatment and less than desirable finished product as has been seen at other buildings. Further, a number of the elements are closely interrelated, and need to be addressed concurrently to ensure proper and effective flashing installation.

Finally, it will be detrimental to the building, its daily use and for income-generating rentals, to be in a constant state of construction and surrounded by unsightly staging for a number of years. Not only will costs continue to rise, but the extended general conditions will drive up costs.

As such, it may be warranted for the Committee to consider whether or not borrowing against future CPA collections may be appropriate in the case of Arlington's historic Town Hall; notably, over 20 municipalities have used bonding as a tool specifically for the preservation of their City/Town Halls. Arlington may wish to do the same in the near future. This will provide significant relief to the Town's budget and its financial health and condition should the capital plan (which has not accounted for this project) be asked to assume the debt service.

1. **Goals**: To stop further damage to the interior of our amazing Town Hall, and to develop a plan to perform long overdue preservation and restoration activities related to the façade of the building.

2. **Community Need**: Town Hall plays a central role in the administration of our local government and the delivery of services. We need to protect our valued civic center in perpetuity.

3. **Community Support:** Town Hall serves all residents and hosts Town Meeting and countless other governmental activities; however, included are letters of support from staff members who are impacted daily by the worsening conditions- including the Town Clerk, Town Treasurer, Select Board Office and Events Coordinator Patsy Kraemer. The historical importance of the structure is highlighted in a letter from historian Richard Duffy.

4. **Project Documentation:** Recent pictures follow, and videos are available upon request. Additional documentation is provided with the report from Design Associates.

5. **Timeline:** The Town is already pursuing initial laser scanning efforts to advance the construction documentation process in advance of funds being awarded (hopefully). This would allow the project to proceed in fall of 2023.

6. **Credentials:** The Town will work with appropriately credentialed design professionals, and coordinate as necessary with DPW and Facilities. The applicant resides in the building, has completed a number of capital projects at the building, and is well-positioned to direct and monitor on-site activities.

7. **Budget:** The total project budget is $385,000, with approximately 10-12% ($38,500-46,200) projected for soft costs (design and additional scanning). *Note: You will find the consultant estimates a $368k CY2022 budget, and recommends a 8% escalator. This would roughly equate to $397k; however, we are undertaking initial scanning and documentation efforts now with existing capital funds, so the budget has been reduced accordingly.*

8. **Other Funding:** The applicant intends to pursue additional grant opportunities that may be available.

9. **Maintenance:** Maintenance activities are funded via the Facilities Department operating budget.

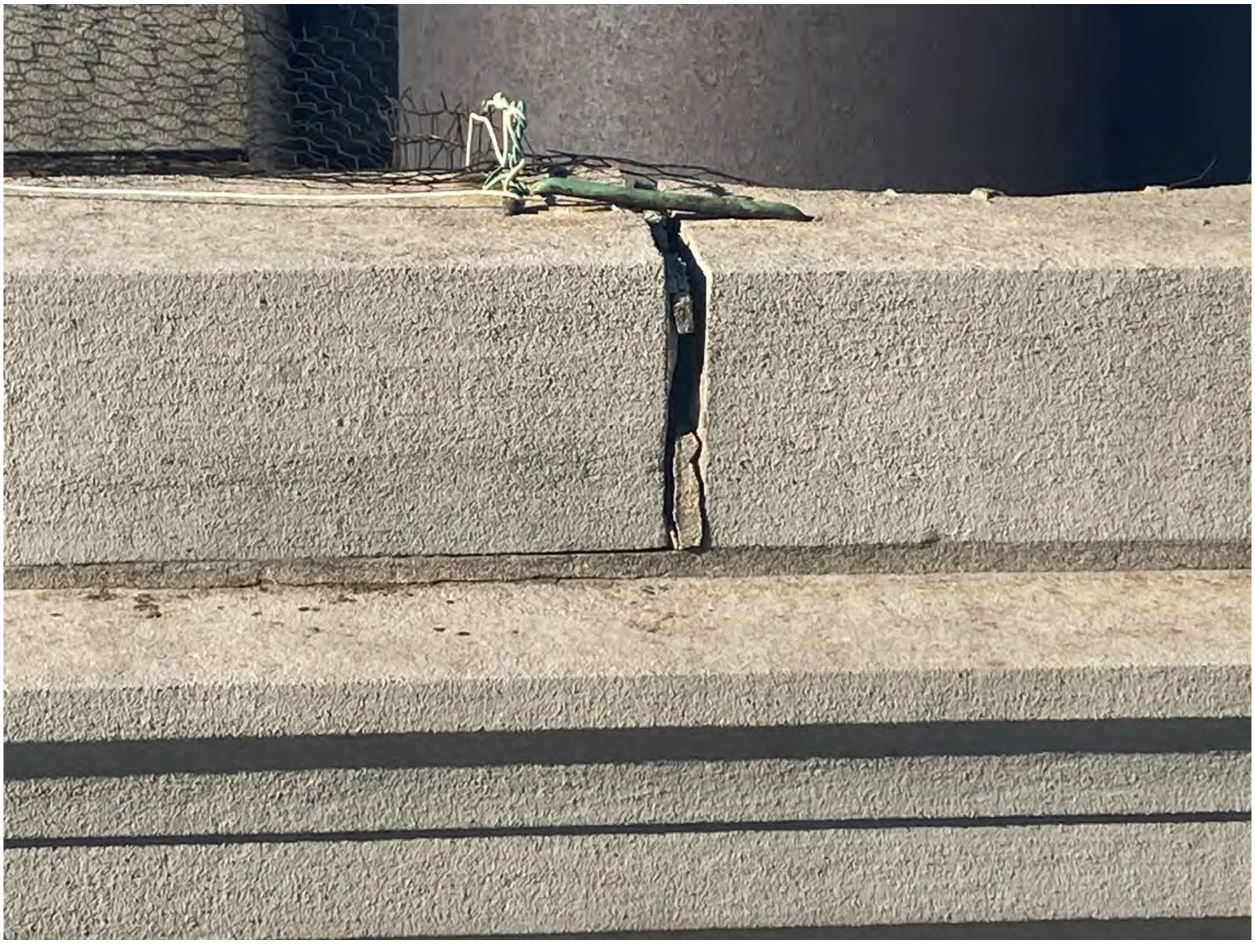
10. **Impact on Town Budget:** The restoration of Town Hall is an expensive but necessary project not currently accounted for in the Town's Capital Plan, as funded annually at 5% of the Town's revenues. Moreover, maintenance costs to spot repair leaks, repair plaster and repaint walls and ceilings on an ad-hoc basis would be immediately reduced.

Photos Taken December 9, 2022:

Reference 9

Reference 9

Reference 9



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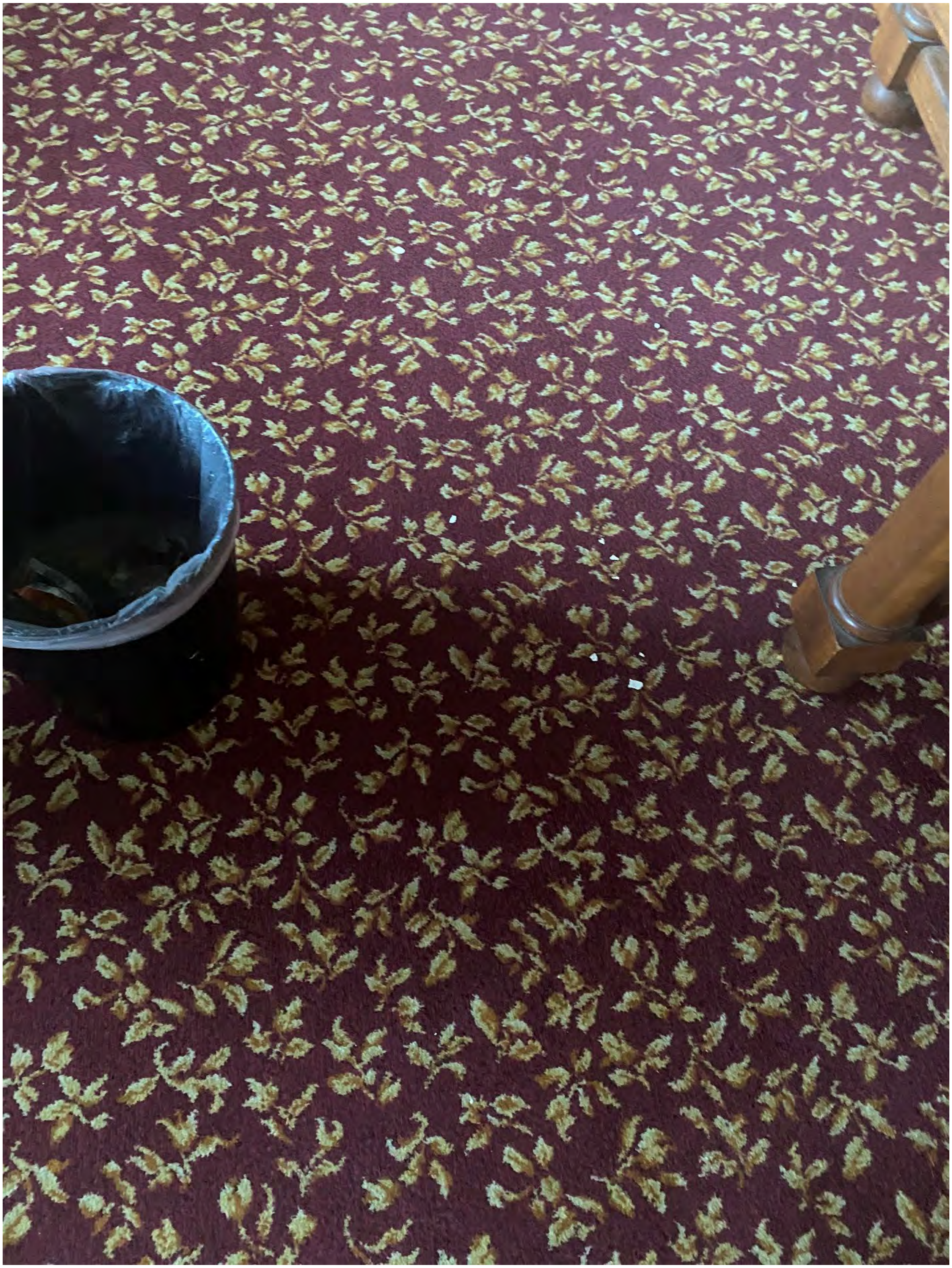

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ARLINGTON TOWN HALL
EXTERIOR CONDITIONS ASSESSMENT
&
RECOMMENDATIONS

December 2022

Design Associates, Inc
December 2022

Contents

Executive Summary

In October 2021, Design Associates was hired by the Town of Arlington to assess the condition of the exterior envelope of the historic Arlington Town Hall. 1912, limestone-clad Classical revival building and its 1955 rear addition feature prominently in Arlington center's civic block. Designed by R. Clipston Sturgis with later work by his successor firm, the handsome building houses much of Arlington's municipal functions and is host to town meetings and many events each year. It has been a privilege to study and provide recommendations for the preservation and maintenance of the exterior envelope of this significant civic landmark.

Though built of durable construction materials, weather and time have taken their toll. The terra cotta is failing at the dome, and pieces could fall and harm someone. In addition, the structural steel supporting the building is rusting. The tower is a character-defining feature of the historic town hall but is beyond repair. It must be documented to allow for accurate reconstruction and then disassembled and a temporary roof installed at its location.

For the rest of the Town Hall and Annex, incremental repairs over the last century have staved off significant losses but will be less and less effective moving forward. Short-term patches are becoming increasingly necessary and widespread, but unlike a band-aid, there is no healing under the patch. Instead, though the deterioration is temporarily addressed, it will begin again and accelerate when the patch fails. Instead, a proactive approach is required.

Patrick Guthrie, President of Design Associates, met with James Feeney, Deputy Town Manager, in November 2021 to discuss the scope of the project and its goals. In keeping with a proactive approach, a comprehensive report on the roofing, walls, doors, and windows outlining repair work, suggesting a sequence for phasing the job, and providing opinions on cost for capital budgeting was requested. After the first submittal, Mr. Feeney asked that the project scope be re-described as a single comprehensive project. That projection was submitted in October 2022. Between the two submittals, revised figures for window restoration and cupola reconstruction were received, and commentary on general conditions savings for a single, large project.

The work to document, dismantle and protect the roof at the cupola location is estimated at, $**368,060.00**including contingency and professional fees. The entire exterior restoration project, excluding documentation and removal of the cupola is estimated to be

$7,795,924.50

Project Team

Design Associates' team included Patrick Guthrie, President, and Scott Dignacco, Architectural Designer. Ivan Myjer, President of Building and Monument Conservation, provided the masonry conditions evaluation included in the appendices of this report. Ivan is familiar with the town hall, especially the limestone cladding, and has consulted previously on multiple town projects. Kronenberger and Sons, Inc. restored two of the town hall windows in early 2022 and provided the restoration categorization criteria and cost projections for fenestration adopted by this report. Charles Curran, President of Paul F. Dutelle Roofing, walked the roofs of the town hall with Patrick and Jim to evaluate conditions and provide costing and phasing suggestions. Finally, Eduordo Fragale, President of Fragale Building Corporation, made multiple site visits to assess the extent of masonry repair and evaluate the replacement cost for the cupola cladding in association with Northeast Precast of New Hampshire.

Opinions of costs from the team were based on recently completed work of comparable scope and direct quotes from vendors.

These figures represent costs for public bid projects in the third quarter of 2022. An eight percent escalation factor should be added in for each year subsequent to 2022.

The Report

Part One of the report contains the conditions and structural integrity assessment, includes a brief physical description of the building, and then a more detailed breakout of the features of the building, condition, and recommended treatment.

Part Two is a tabulation of opinion of cost for a single project at the Town Hall to address the concerns raised in this assessment.

Part Three consists of drawings of the Town Hall and Annex produced for this assessment to provide quantity take-offs for tradesmen who provided opinions of cost.

Part Four are the consultant reports from Silman Engineering and Building and Monument Conservation on the Town Hall Tower and Exterior Masonry.

Moving Forward

With an understanding of the building fabric's current physical state, the structure's stewards now have a framework to guide its preservation.

Methodology

The team made several trips to the Town Hall to gather information and observe conditions. Observations were visual, no destructive testing was conducted.

In preparation for the visits, existing condition drawings based on dimensions obtained from original construction documents and an EagleView © report were prepared by Design Associates and shared with the team.

An initial meeting in November 2021 confirmed with James Feeney the scope and intent of the report. In addition to confirming intent, James Feeney showed Patrick a video of water leaking through the town hall cupola into the Lyons meeting room and photos of failed concrete and rusted steel in the structure. Patrick recommended immediate investigation of the cupola roof and its framing and provided contact information for Silman engineering. Staff from Silman visited the town hall and prepared a trip report. Although Silman Engineering made their visit outside the scope of this report, their summary of observations is included in section three.

After contract approval, Design Associates staff visited in February to confirm measurements for As-Built diagrams. At the end of February, Patrick Guthrie and Ivan Myjer, Building and Monument Conservation, reviewed masonry, roofing, and fenestration conditions. A subsequent visit on March 14, 2022, added Dutelle Roofing and Fragale Building for additional roofing and masonry costing analysis and commentary. Dutelle returned on the 18th to further assess and measure roofing materials and quantities, especially at the interface between the slate roof, flashing, and stone balustrades. Design associates met twice with the roofing and masonry contractors to evaluate the approach and costing given the turbulent environment of construction pricing in 2022. Preliminary pricing and a phased approach were shared with the Town August 2022. Subsequently, revised numbers based on a single-phase project and with updated window numbers provided by Kronenberger and Sons, Inc. and a substantial increase in cupola replacement costs based on additional analysis by the mason and the precast stone vendor were delivered to the town on October 3, 2022.

The final report for submittal with an application to the Community Preservation Committee was delivered on December 7, 2022.

Acknowledgments

James Feeney and the town of Arlington facilities department personnel facilitated access and accommodated multiple visits by team members during the discovery phase. Their candid commentary and support for the project were invaluable.

Conditions Assessment

This section of the report categorizes the existing condition of the Town Hall exterior envelope. The scope of this report excludes the interior. The narrative is derived from on-site examination, photographs, and reports of technical consultants.

For this report, the Town Hall is divided into the Town Hall (built 1912) and the Annex (constructed 1955).

Descriptions of materials on the exterior will be differentiated by these portions. In this report, the façade of the Town Hall on Massachusetts Avenue is considered to face north. The narrative below describes the exterior envelope features of the Town Hall. The descriptions provide an overview of the building exterior. This is followed by a summary of the conditions and then a building system breakdown of conditions and recommendations.

Town Hall

General Description

The Town hall is a large, symmetrical, two-story building with a full basement. The design is Classical Revival with a plan shaped roughly like a serif capital T. The arm of the T faces Massachusetts avenue and the stem extends south to connect to the Annex. The stem contains a two-story height auditorium and its flanking one-story passage galleries. Crossing the bottom of the stem is an east-west oriented wing the full height of the auditorium. Flanking the fly loft of the auditorium are two hip-roofed Two short wings at the ends of the arm bracket the main façade. All pitched roofs are slate, hip roofs with balustraded parapets. The roofs of the auditorium roof, side aisles, and Porte-cochere are flat.

An ornate, terra cotta cupola, with a large pineapple on top is centered on the ridge of the façade. The ceramic is glazed to match the limestone cladding at lower levels. Clock faces appear on the north, east and west cupola elevations. The cupola is open to the weather above the clock face and under the dome and pineapple.

Building walls are clad in Indiana limestone panels coursed in a stacked block pattern. Roof edge balustrades, eaves, cornices, and the Massachusetts avenue entry portico are all rendered in carved limestone.

Fenestration consists of aluminum storm windows protecting wood, true-divided light windows and wire mesh screens. The monumental front doors facing Massachusetts Avenue are paired, wood doors with large glass panels and bronzed hardware.

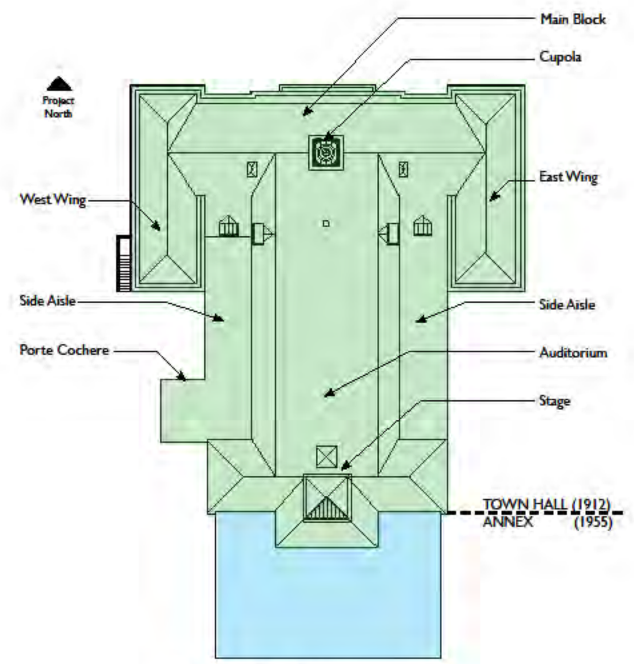
The town hall parking lot is up against the west wall of the town hall stem. Midway down the stem is a porte cochere sheltering entry into the west gallery of the auditorium. The Olmsted-firm-designed Robbins Memorial Garden abuts the east side. At the facade a stone paved plaza with monumental stairs and stone balustrades and fountains and a portico with three pairs of entry doors create a formal entry to the town hall.

Annex

General Description

The Annex is a three story, rectangular plan building joined butted to the rear elevation of the Town Hall at the base of the T-plan. Interior connection to the Annex occurs through the passage and stairways at the south end of the Town Hall. The newer, 1955 Annex is clad in veneer limestone with ribbon windows and has a flat, membrane roof. Building mechanical equipment is mounted to the roof.

Two storefront entry doors, protected by a cantilevered canopy face the parking to the west.



ARLINGTON TOWN HALL KEY PLAN

Approach

The consideration of repairs, maintenance, and future renovations of the Arlington Town Hall should be guided by the significance of the building and site as framed by the National Register of Historic Places nomination for the Arlington Center Historic District.

Historic Building Standards

The Secretary of the Interior's Standards for the Treatment of Historic Properties should be used to inform all work at the building. The Standards provide advice on the preservation and protection of cultural resources and recognize four treatments: Preservation, Rehabilitation, Restoration and Reconstruction. At the Town Hall Preservation is the primary standard, but Rehabilitation is appropriate when contemplating work at the Town Hall where change to meet the needs of current and future users may require introduction of modern materials or approaches. The Rehabilitation standard should be woven into any planning. Reconstruction clearly applies to the cupola.

PRESERVATION is defined "as the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project." At the Town Hall the exterior clearly warrants Preservation. The protection of these features should always consider how to sustain them with the least physical intervention possible.

REHABILITATION is defined "as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural or architectural values." Modifications should be minimally expressed and draw from a sympathetic material palette.

RESTORATION is defined "as the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a restoration project." The Town Hall is largely unchanged – restoration would not be required unless features are lost due to some unforeseen event. It seems unlikely that the historic fire engine doors would ever be reintroduced on the north elevation, but if they were, that would be restoration.

RECONSTRUCTION is defined "as the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location." Understanding the cupola requires removal the following must be kept in mind.

Record as much of physical evidence as possible when documentary to permit accurate reconstruction with minimal conjecture. Reconstruction will include measures to preserve any remaining historic materials, features, and spatial relationships. Reconstruction will be based on the accurate duplication of historic features and elements substantiated by documentary or physical evidence rather than on conjectural designs or the availability of different features from other historic properties and will re-create the appearance of the non-surviving historic feature in materials, design, color and texture. Also, reconstruction will be clearly identified as a contemporary re-creation.

General Application Of The Standards

Materials

When repairs are required, original building materials should be replaced in kind– local stone for local stone, wood for wood, slate for slate. When traditional replacement materials are not available or are economically unfeasible, substitute materials that mimic the look, feel, and workability of original materials may be considered. Care should be taken when deciding to use a synthetic material, however, since modern products may interface poorly with traditional building materials, offer limited longevity versus traditional materials, and experience color shifts and other deteriorative changes.

Roofing

Slate and copper should be replaced with matching material, applied in a traditional manner. Underlayment of modern materials compatible with the historic material, improving thermal or moisture controls and not adversely affecting the historic material are appropriate. Where flat roofing of large surfaces, non-visible to building users or the public must be replaced modern

equivalent material may be used with historically compatible interfaces with slate roofs and at roof perimeters.

Masonry

Stone elements should be replaced with matching material. Mortar formulation is particularly important since soft stone could be damaged by modern mortars where the cement content could make the mortar harder than the stone itself. An appropriate mortar formula should be established and adopted for all repointing campaigns. Clear records of the mortar mix, proportions of tinting pigments, and the application technique, including the final strike, should be documented in the building owner's maintenance records. Actual mortar samples should be retained with the records along with a sample panel on the building. Skilled masons should be employed in preparing joints and sampling should be done with every project to confirm the skill level of the worker. This is particularly critical when the mortar joints are as thin as they are at Town Hall. Cutting a preparing the joints will require great care.

Wood Windows and Doors

Wood windows and doors are character defining features and essential elements in a historic building's distinctive architectural design. Repairing and weatherizing existing wood doors and windows is always the preferred approach for historic buildings and provides energy efficiency comparable to new elements. When windows have exceeded their useful lives and retention is not practical or economically feasible, an approach that combines repairing old windows where possible and introducing new windows where necessary is recommended. At the Town Hall the various storm windows installed over the historic windows, when functioning, provide protection for the windows and increased thermal efficiency.

Paint Finishes

Original paint formulations and colors are character-defining elements that are often lost over time because the paint materials themselves are relatively short-lived. If the intent is to reproduce the original colors or those from a significant period in the building's history, they should be based on the results of a scientific paint analysis. Traditional lead based paints, which offer excellent longevity, durability and color stability, are no longer available in the United States. The highest quality latex-based paints available should be employed instead, after thorough surface preparation and priming.

Exterior Condition Summary

The Town Hall and Annex are constructed of durable materials, but time and use now require extensive, repair and materials replacement.

The cupola is in the most dire condition and requires immediate attention. Slate roofing and copper flashing systems are at the end of their service life. All mortar joints in the stone walls need repointing and select stonework should be repaired or replaced. Wood windows in the 1913 building require repair. Storm windows throughout no longer operate or provide sufficient energy efficiency. Cranks for the awning units of the aluminum framed windows at the 1955 annex require replacement as well as screens at those units. The town hall doors are an eclectic collection of the original wood and some aluminum store-front type openings in varied conditions, but all require repair.

Recommendation

Address the cupola documentation, removal and temporary roofing first.

Once the cupola is secured, the Arlington Town Hall requires a comprehensive program of restoration. Extant, historic materials across the entire building, while durable require, repair or replacement. The extent of the work suggests a single, 18-month long construction project as being more efficient with time, money and general conditions than phasing the work of many years.

Existing Conditions Detail and Recommendations

Cupola Existing Conditions

The cupola condition is cause for immediate concern. There is active leaking through it into the Lyons meeting room. In addition structure and masonry have been evaluated as poor by Silman Engineering and Building and Monument Conservation, respectively with both citing significant deterioration. For reference their reports are included at the end of this assessment. In summary, at the clock level and higher the steel embedded in concrete and concealed within terra cotta blocks is rusting which is rupturing concrete casing and has cracked terra cotta blocks at the interior and glazed terra cotta over the entire face of the cupola. Silman recommends removal of cladding and concrete to access the rusting material for repair and Building and Monument Conservation notes the very poor condition of the decorative terra means the cladding will not survive removal. Even without removal for structural access, the poor condition of the terra cotta presents an immediate hazard. There is nothing to preventing cracked pieces from falling off the cupola and posing a danger to the public.

Figure 1: Cupola north elevation

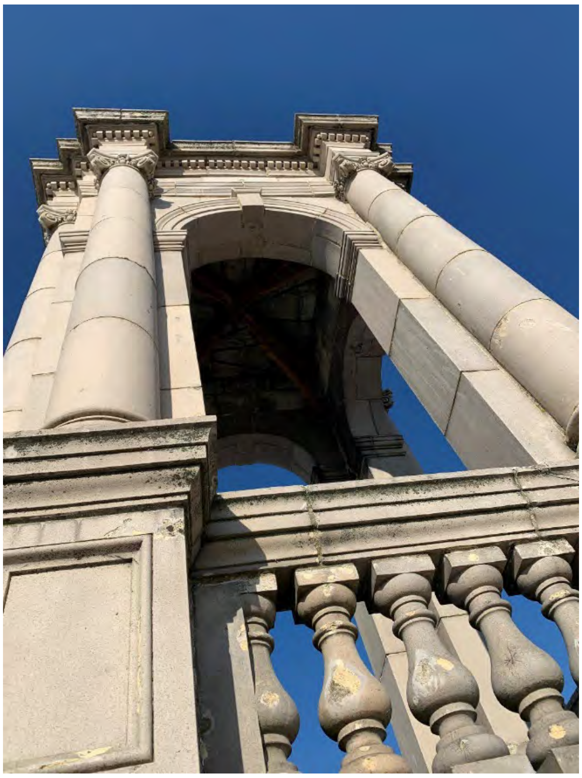


Figure 2: Note failing glazing on terra cotta

Figure 3: Detail of cracking and failing terra cotta

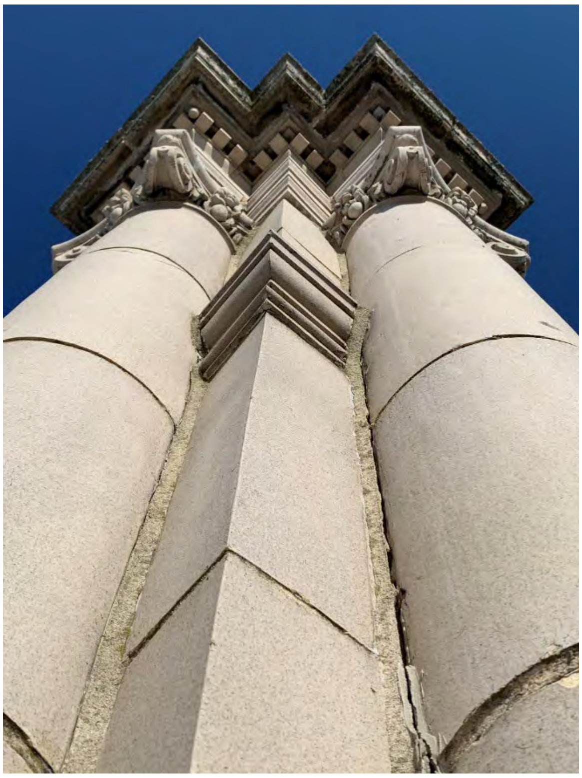


Figure 4: Open mortar joints and cracking

Figure 5: Rusting structural steel cracking encasing concrete

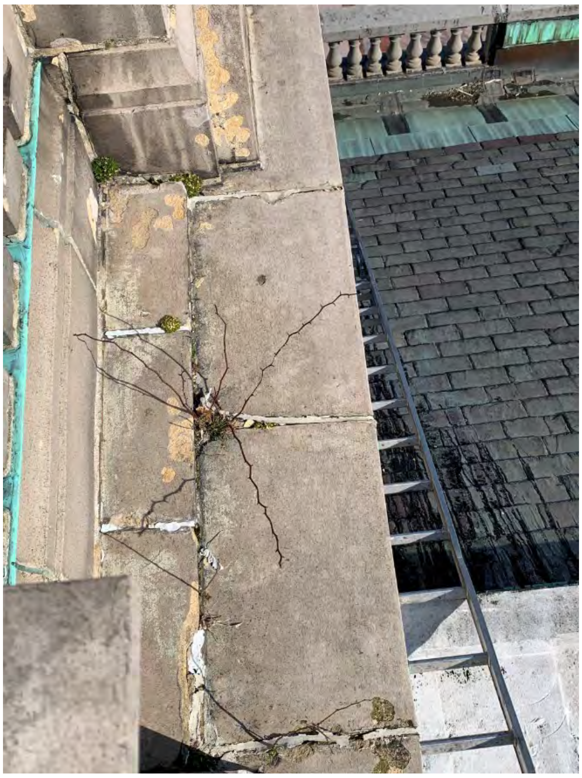


Figure 6:Caulking in failed joints and plants growing in the resultant pockets

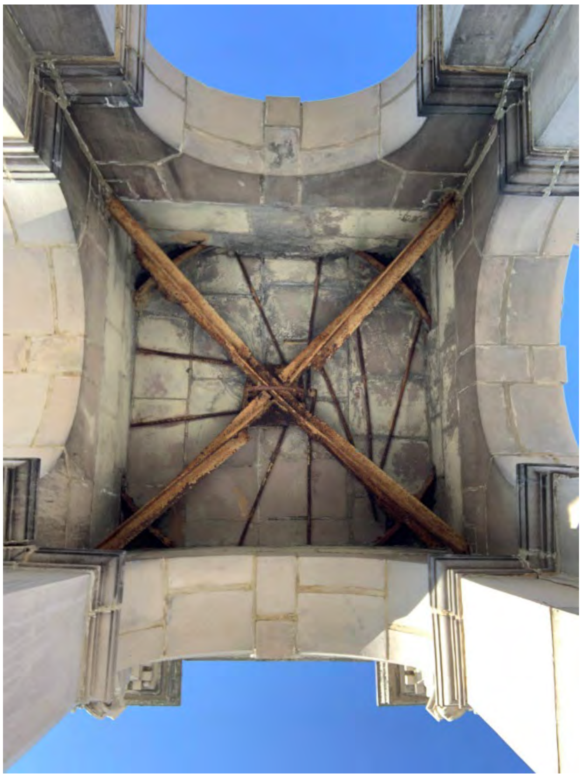


Figure 7: Rusted steel support for the dome

Figure 8: Decorative terra cotta and structural terra cotta

Figure 9: Failed glazing and cracking

Figure 10: Failed glazing and cracking

Figure 11: Failed caulking at joints, plant colonies, failed glazing and cracking

Figure 12: Deterioration of decorative piece

Figure 13: Failure of glazing and cracking

Figure 14: Failure of glazing revealing the softer underlying ceramic

Cupola Recommendations

Given the condition of the cladding and the steel the first priority at the Town Hall is documenting the cupola with a laser scanner to record all the ornamental detail and dimensions for future replication. This should be done immediately. Once documented, the existing cupola should be disassembled for safety and the location roofed over. Elements of the cladding that remain intact upon removal may be stored as examples of the historic construction. Still, the inherent vulnerabilities of the aged material and limits on structure options with the existing terra cotta preclude reinstallation at the town hall.

Next, a reconstruction design for the cupola including new structure and pieces mimicking the glazed terra cotta should be prepared. The scanned information from the original cupola will guide the reconstruction to ensure the historic character is recaptured. The steel structure will be designed to comply with the current building code requirements for structure. Roof drainage for the reconstructed cupola will address leaking at the Lyon's hearing room.

Cast stone is recommended for the exterior pieces. Cast stone will be durable and can be designed with integral reinforcement that can be integrated into structural design in ways that fiberglas and terra cotta cannot. The cast stone can be made to closely mimic limestone from the building façade and unlike the glazed surface of terra cotta pieces, the color of the cast stone is integral to the unit.

Roofing Existing Conditions

The Town Hall and Annex have several roofing systems. Roofing conditions were evaluated by Paul F. Dutelle roofing company, experienced in slate, copper, and flat roofing. Each system and its condition are described below. Recommendations follow.

Slate roof Existing Conditions

The original slate roof system on the Town Hall has been exposed to over a century of New England weather and is beyond the end of its service life. Two slate colors are used; mottled purple/ green and sea green/unfading green. Evidence of temporary repairs to slate and associated copper flashing are evident throughout. Mis-matched slates, aluminum, and galvanized metal patches are scattered across the roof. Roofing cement is used extensively. Much of the flashing is covered with tar and roofing cement. Solder joints are cracked, and some copper has split. Copper flashing between slate and the stone parapets is not flashed through the base of the parapets, creating a vulnerability at the roof perimeter, its flat surface has many membrane and cement patches. Water is seeping between the copper joints where the flashing meets the slate roof. There are nearly 110 squares of slate roofs at the Town Hall and 1200 square feet of perimeter flashing at the parapets.

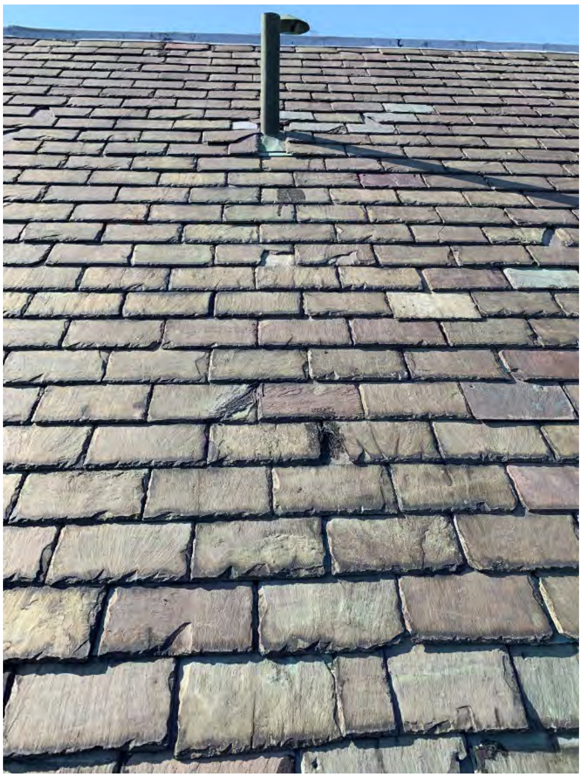


Figure 15: Broken and mis-matched slates at the main block roof. Note the edge conditions of slates showing extreme wear

Figure 16: Broken hip slates, mis-matched sizes and colors at repairs,

Figure 17: Slates that have fallen off roof and broken slate debris at one of the roof valleys

Figure 18: Standing water, cracked solder joints and rubber patching at the base of the slate roof along the parapet

Figure 19: Pitted copper flashing at the base of the slate roof and water running out from under the copper.

Slate roof Recommendation

Remove the existing slate and underlayment and copper flashing. Install new unfading green slate, underlayment, and 20-ounce red copper flashing.

Temporarily remove the stone parapets and cut reglets into piers to install new 20-ounce copper through flashing. Extend flashing up under new slates.

Flat roofs Existing Conditions

The flat roof of the auditorium has been painted with a fibrated coating to extend the life of an older flat roof below. The coating is cracking and peeling. Flat roofing at the porte cochere, side aisle and Annex appears to be torch-down roofing with gravel on top. Standing water was observed around roof-top equipment. There are approximately 10,500 square feet of flat roofing. According to evaluation by Paul F. Dutelle Company, the roofing is near the end of its service life.

Figure 20: Coating applied to the torch-down flat roof of the auditorium is wearing out along seams

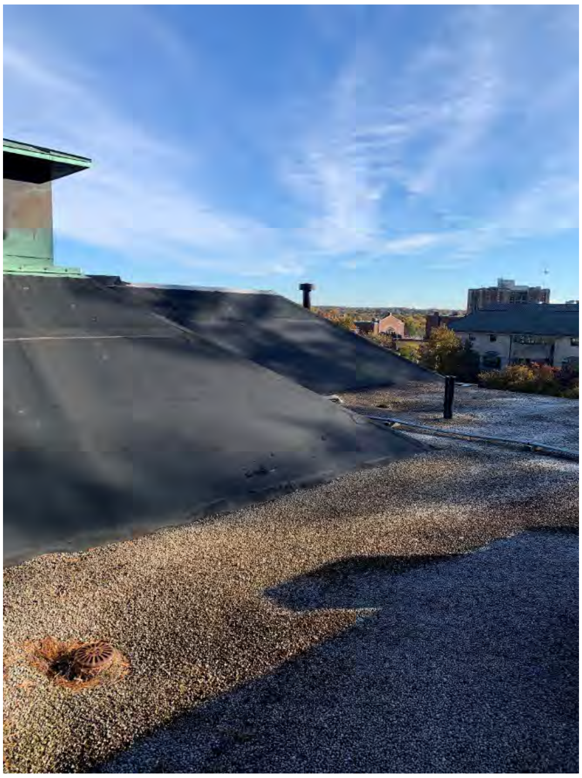


Figure 21:Tar and gravel cover the Annex roof and membrane covers the south slopes of the Town Hall roof. Note the standing water in the equipment shadows on the Annex roof.

Figure 22: Edge of auditorium roof looking toward Annex roof. Stage ventilator is at the right side.

Flat roofs Recommendations

Remove the existing roof, ballast, and underlayments down to the sheathing. Replace with a vapor barrier, tapered insulation, Dens Deck, fully adhered light-colored TPO, and copper edge flashing around the perimeter. The light color will help with Town Hall and Annex cooling costs.

Flat and Standing Seam Metal roof Existing Conditions

The headhouse of the auditorium stage, mechanical headhouses at the auditorium flat roof and vents at the town hall roof are copper with pyramidal roofs. The auditorium stage head house is standing seam with a skylight in the south plane of the pyramid. The roofs are metal at the end of their service life.

At the entry portico, the roof is flat seam metal with a loosening membrane cover regletted into the stone parapet. The portico roof is about 120 square feet.

Figure 23: Typical condition at standing seam roofing with solder and caulking repairs over pitted copper.

Figure 24: Ventilating head house at main block gable. Note open ventilator pipe missing its cap and fatigued solder joints.

Figure 25: White membrane applied over flat seam metal at the portico roof. Note the reglets anchoring the white, loose membrane and accumulated debris due to ineffective drainage.

Flat seam and standing seam metal roof Recommendations

At the head houses, remove existing roofing and underlayment to the sheathing. Install new, high-temperature underlayment. Install new, standing seam copper roofing.

At the Town Hall entry portico remove the existing covering, roof and coating and underlayment. Install a new flat seam roof, pitched to drain to scuppers. Coordinate this work with masonry repair. Remove the stone balustrade and provide through flashing/roofing at the base during the roof replacement.

Roofing overall Recommendation

For increased efficiency and economy fully stage the exterior of the Town Hall and Annex in coordination with masonry and window work.

Windows Existing Conditions

Town Hall wood windows have weathered nearly ten decades. Aluminum storm windows have helped protect them, but exterior glazing is failing, years of gouging by opening or closing when the locks were not fully secure have left wood of meeting rails and muntins in need of repair. Sash cords in double hung windows have frayed and broken. Casement hardware is frozen. All the Town Hall windows are painted on the exterior and have clear finish on the interior. Exterior paint is failing and recent window restoration detected lead paint at the sash and trimi. There are 110 windows at the Town Hall that range in size from 8 to 30 and as large as 70 square feet. Windows were evaluated by Design Associates in consultation with Kronenberger and Sons who recently restored two windows at the Town Hall.

Aluminum ribbon windows at the Annex are in good condition. At time of inspection (4/2022) seals and desiccants in the double glazed units seemed intact. Screens and cranks were in fair condition though many of the awning window cranks were stripped or pins were sheared. The steel lintels at the windows show rust.

Figure 26: Town hall windows are large, multi-lite, single-glazed, double hung units. Interiors are clear finish and exteriors are painted.

Figure 27: Many muntins, like this one at the auditorium, require replacement.

Figure 28: More damage at the auditorium.

Figure 29: Window interior wood is dried out and needs treatment. Exterior glazing is also failing and needs replacement.

Figure 30: Another damaged muntin.

Figure 31: Temporary repair to a window joint.

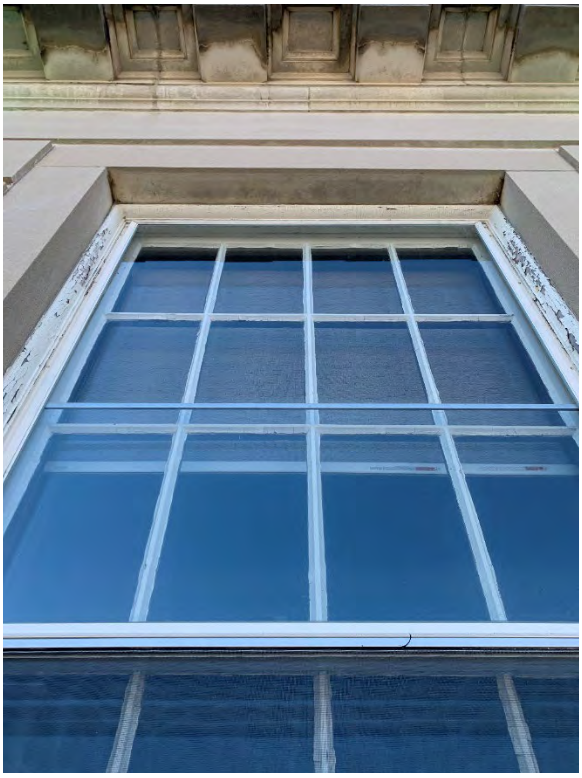


Figure 32: Exterior aluminum storm stuck in a partly open position.

Figure 33: All exterior woodwork at windows is coated with failing lead paint.

Window Recommendations

Remove sash and record location for reinstallation. Retain existing storm windows for weather protection until restored units are reinstalled. Remove glass and glazing and paint from sash. Dispose of lead paint and hazardous materials in caulking and sealants. Repair damaged wood with wood Dutchmen. Reinstall glass and reglaze windows. Paint exterior, including the trim. Refinish the interior, staining to blend with existing woodwork in each room. Check and adjust hardware. Replace all sash cords with sash chains Refinish jambs and sills, staining as necessary to match adjacent woodwork.

Replace aluminum storm windows with new, two-track, single-hung, aluminum storm windows custom fit to openings.

Replace torn screens at the Annex ribbon windows. Replace crank hardware on awning units.

Address the rusting lintels when repointing is conducted by removing rust, applying a zinc-rich primer and epoxy coating the steel.

Door Existing Conditions

The wood doors at the Town Hall entry require wood repair where water and de-icing salts have damaged the wood and hardware adjustments to the automatic openers which are out of adjustment and closers which are stiff. The exterior and interior finishes are worn, the hardware has dulled. The clerks office wood screen and paneled door are also very weathered weathered. The wood door/window combination from the Lyons meeting Room to the balcony over the portico is in extremely poor condition. Exterior access to the Town Hall basement on the west side is via a steel door that is rusting. The aluminum frame and glazed doors into the auditorium side aisles and into the Annex are in fair condition.

Figure 34: One of three double doors into the Town Hall vestibule.

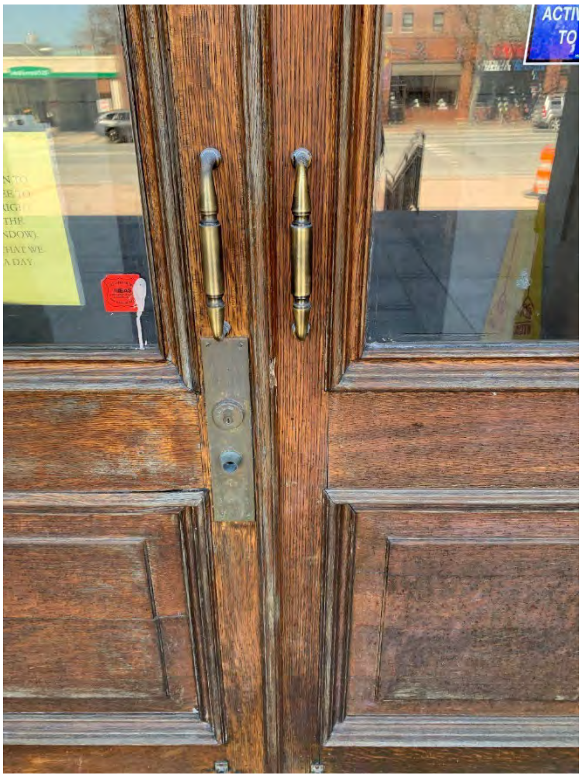


Figure 35: Worn finishes on this door are typical. Note the historic knob escutcheon at this door with know removed when the door was converted to automatic opening.

Figure 36: Bottom and top rails of doors are worn and do not provide good weather seal.

Figure 37: Bottom and top rails of doors are worn and do not provide good weather seal.

Figure 38: Adjustment to the automatic door opener coordinator device is required.

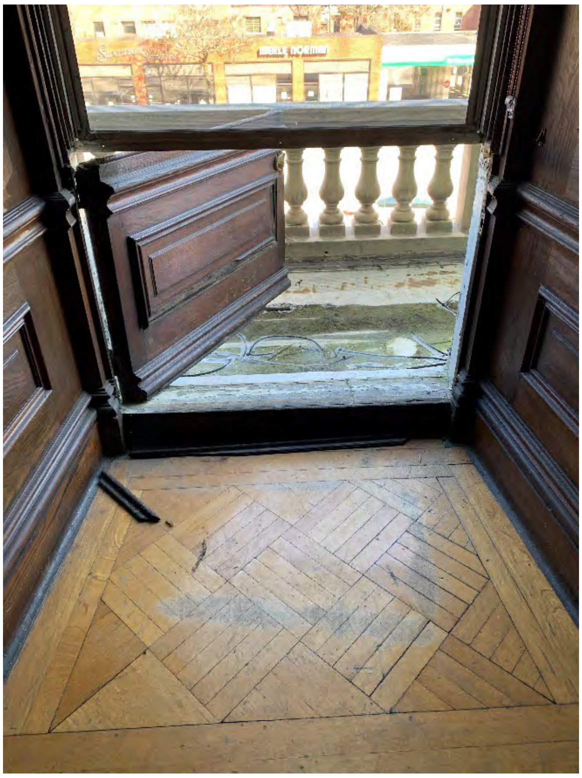


Figure 39: The half-door onto the portico balcony has fallen apart and needs to be re-built.

Figure 40: Pieces are falling from the half door to the portico balcony.

Figure 41: An original door at the clerks office of Town Hall has an original wood screen door.

Figure 42: The woodwork of the screen door and original door requires refinishing. Weatherstripping should be applied adn the hardware adjusted.

Figure 43: The west side aisle is accessed with this aluminum door.

Figure 44: Entry to the Annex. Door weatherstripping should be replaced. Note the light fixture and sagging ceiling plaster at the awning.

Door Recommendations

Dismount, remove hardware and epoxy repair the stiles and rails of the Town Hall entry doors. Stain wood to match adjacent wood and provide a satin finish clear coat to the wood. Refinish the wood trim at the opening. Adjust the automatic openers so door pairs are properly coordinated for opening and closing. Replace weatherstripping and adjust the resistance on the manual closers to make door opening easier. Reduce, if possible, the use of de-icing salts.

Reconstruct the Lyons meeting Room balcony door, retain hinges, provide new latch, weatherstripping, sill pan flashing. Upper half of opening is an operable window that will be repaired under the window repair project but with weather stripping and hardware coordinated with the door for a good weather seal.

Treat rust at the basement door and repaint.

Replace the weatherstripping at the aluminum entry doors and adjust automatic and manual closing mechanisms.

Skylights Existing Conditions

There are three skylights at the Town Hall. Two, copper-clad, 4-lite, shed skylights on the south slope of the front block roof illuminate staff restrooms. A third skylight is located in the south slope of the stage skylight. The copper is pitted, the wired glass is cracked and glazing is failing. In addition the copper crickets are painted over with roof patching material.

Figure 45: The shed skylight at the west bathroom. Note the aged copper and the over-coated copper cricket as well as all the replacement slates along the roof valley.

Figure 46: The east shed skylight. The worn copper and cracked glass are evident.

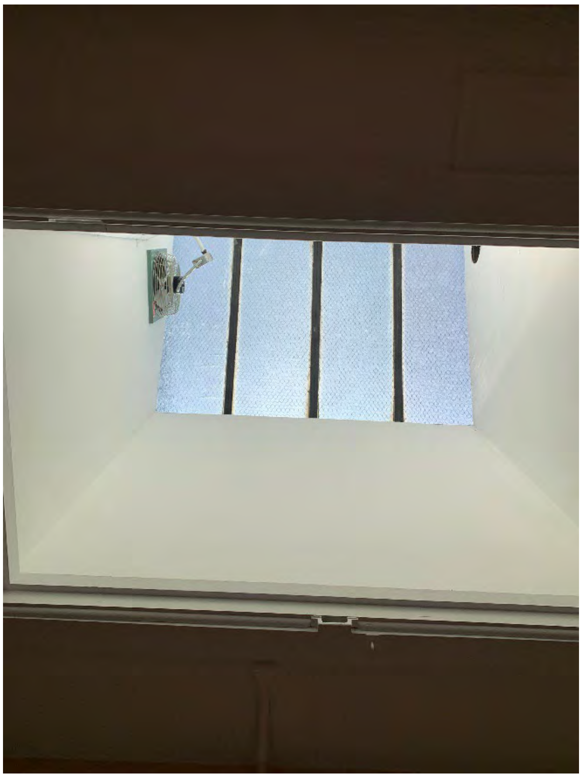


Figure 47: View up to skylight at the east restroom. Note the rough appearance of the glazing along the muntins.

Figure 48: The stage skylight is visible at the ventilation monitor. It should be repaired when the monitor copper is replaced.

Skylight Recommendations

Restore the restroom skylights. Remove and replace the exterior copper cladding. Build new frames with insulated, laminated, safety glass conforming to current code requirements. At the stage skylight, and while the ventilator head house is being clad in copper, reconstruct the skylight at the

south slope of the pyramid roof. Build a new frame with insulated, laminated, safety glass conforming to current code requirements.

Walls Existing Conditions

All 17,000 square feet of the Town Hall and the Annex exterior limestone walls require repointing. Failed mortar joints have allowed water to infiltrate and accelerate weathering of the stone. Joints in the stonework that face the sky need t-caps installed to prevent water entry. Limestone panels at the west elevation and at the Massachusetts Avenue entry are damaged from de-icing salts and freeze-thaw cycles. Stone balustrade units are cracked by rusting steel pins. Stone is discolored by dormant and active biological films. Repairs to cornice stones using soft steel are rusting and further damaging the stones. Soft steel anchors to stone at the west wing of the Town Hall have rusted and caused spalling of stone panels. Wall condition was evaluated by Building and Monument Conservation and their full report is included in this document.

Figure 49: A bronze staple joining two balustrade pieces together. Note the caulking in the skyward facing joints. A t-cap needs to be applied to these joints.

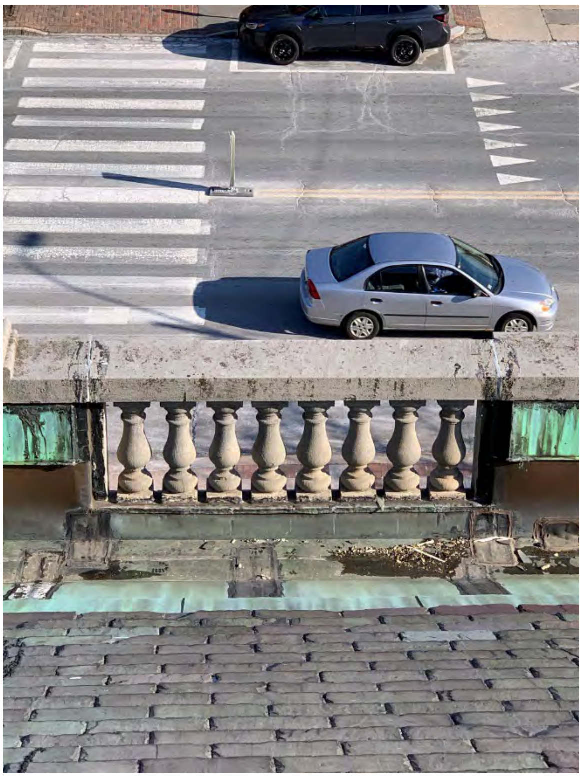


Figure 50: The flashing at the parapet should continue beneath the parapet stones to stop water penetration below.

Figure 51: Limestone along the west wall discolored by water absorption and application of de-icing salts.

Figure 52: Rust on lintels at the Annex. Treat the rust before it damages the stone work.

Walls Recommendations

Fully stage the exterior of the Town Hall and Annex in coordination with roofing work. Repoint the stone walls of the Town Hall and Annex with a soft repointing mortar to prevent damage to the limestone. Install t-caps at skyward-facing joints at parapets and balustrades. Replace limestone blocks damaged by salts and frost at the Massachusetts Avenue entry and along the west elevation. Consider using a light-colored, buff granite similar to the paving granite at the main entrance to visually blend with the limestone and be less vulnerable to frost damage and de-icing salts or use cast stone based on the cupola reconstruction match to limestone. Replace rusted pins at stone balustrades with bronze or stainless steel pins when the balustrade is removed to install new flashing at the perimeter of the Town Hall roof and at the portico over the main entry. Gently clean stone during repointing which will reduce the prominence of biological films for the near term, but note that growths cannot be fully eradicated and will slowly return. Remove rusting embedded metal anchors and repair staples and replace failed stone or repair with bronze or stainless steel staples and pins as required. Replace stone panels where anchors have caused spalling. If possible, reduce the application of de-icing salts around entries.

Commission a design to improve drainage on the west parking area to direct water away from stone walls.

Other Items

Some issues at the Town Hall and Annex apply to single elements. These are called out below following the condition and recommendation format used previously in this assessment.

Annex Awning Existing Condition

The aluminum trimmed awning at the Annex west entry is supported by two tension rods anchored to the west wall of the Annex. There is deflection at the roof and it no longer drains properly. The exterior plasterboard ceiling and lighting need replacement. The trim is dented at the northwest corner and the tension rod anchor points are rusting.

Figure 53: Annex awning. Note the rusting at the support rods, defelection of the roof toward the northwest corner and the dropping plaster ceiling.

Annex Awning Recommendations

Remove roof and plasterboard. Install tapered insulation, a fully adhered TPO roof directed to scuppers. Repair the metal rim and framing.,Install a new exterior plaster board ceiling and new lighting. Remove rust from the anchor rods and paint with a zinc-rich primer and epoxy coat for finish.

Basement Areaway Existing Condition

An areaway is located at the southwest corner of the Town Hall west wing. The perimeter pipe rail and metal grate cover are rusting.

Figure 54: Areaway metal cap. The rusting pieces should be treated and painted.

Figure 55: Rails and the steel door at the areaway.

Basement Areaway Recommendations

Remove rust from the steel and paint with a zinc-rich primer and epoxy coat for finish.

Basement Window Vents and Grilles Condition

Various grilles and vents have enclosed and filled many of the basement windows of the Town Hall. The decorative grilles are rusting. The vents, combinations of louvers and sometimes PVC piping are not attractive but appear to be in fair condition. Some may no longer being used.

Figure 56: Deteriorated louvers to be replaced if in use.

Figure 57: Other louvers. Determine if functioning.

Figure 58: East side security grates are rusting and need painting.

Basement Window Vent and Grille Recommendations

Remove rust from the steel grilles and paint with a zinc-rich primer and epoxy coat for the finish. Evaluate all vents for function. Remove those no longer required and reinstall windows. Replace active, but damaged louvers.

Chimney Existing Conditions

Two, limestone clad chimneys at the Town Hall appear to vent mechanical spaces. Mortar at the cladding is eroded and the mortar at the brick back-up is severely eroded. A circular, rusted vent pipe extends out the top of the west chimney. A broken wood frame is perched on the east chimney.

Figure 59: East chimney at the Town Hall. The wood and wire debris will be removed when repointing is done.

Figure 60: The west chimney includes a rusted sheet metal pipe stack.

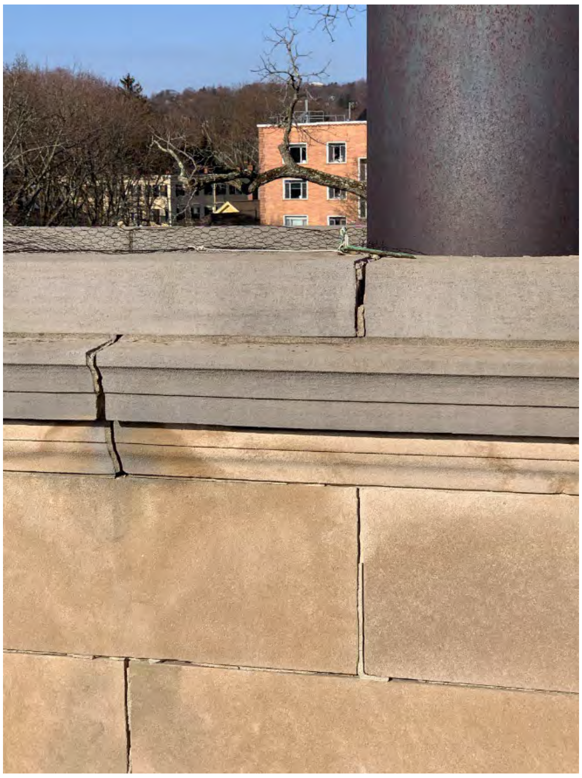


Figure 61: Detail of typical chimney masonry condition. Note all the open mortar joints.

Chimney Recommendations

Pointing would be carried out along with the wall repointing. Remove the rusted vent pipe and wooden frame. If the chimney's are not in active use, cap the opening with a stone slab. If active, when repointing, install t-caps at the skyward facing stone joints and establish a mortar wash to protect the tops of the brick back-up.

OPINION OF COST

The work to document, dismantle and protect the roof at the cupola location is estimated at, $**368,060.00**including contingency and professional fees.

The entire exterior restoration project, excluding documentation and removal of the cupola is estimated to be

$7,795,924.50

These figures represent costs for the last quarter of 2022. An eight percent escalation multiplier should be added every year after 2022.

These figures include design and engineering fees and a 15-percent concept design contingency reflecting the potential for scope modifications as the project moves into the construction document stages.

Costs were developed by the team based on unit cost data from recent completed work of comparable scope and similar materials in a public bid environment. The costing was applied to work areas derived scaled plans (included in Appendix A) and from field observation made possible by the assistance of Town of Arlington facilities staff. The chart below is divided into ten columns:

Column No.	Explanation
1.	CSI Master Format ID – An industry identifier number for the type of repair
2.	CSI Description – An industry description of the work
3.	Description of the item being repaired
4.	Number – Reserved for number of windows or doors of a specific description
5.	Quantity – Area or unit count of item being repaired
6.	Unit of measure for the quantity
7.	Cost of work per unit
8.	Line total – Cost of the quantity times cost per unit of quantity.
9.	Subtotal – Cost of all items per CSI division
10.	Total

COST CHART

ARLINGTON TOWN HALL OPINION OF COSTS REVISED AND AS SINGLE PROJECT									
CSI Code	**Item**	**Description**	**Number**	**quantity**	**unit**	**cost/unit**	**line total**	**subtotal**	**total**
	Division 1-General Requirments	Added to General Conditions Below Construction Cost							
01 52 00	construction facilities and temporary controls	-		52	week	$250.00	$13,000.00		
01 52 10	Crane and lifting	-		10	uses	$3,500.00	$35,000.00		
01 52 19	Sanitary facilities	-		52	week	$115.00	$5,980.00		
01 54 23	Temporary Scaffolding and Platforms	Roofing and Wall pointing		12	mo	$9,000.00	$108,000.00		
01 54 23	Temporary Scaffolding and Platforms	Cupola		5	mo	$9,000.00	$45,000.00		
01 56 00	Temporary barriers and enclosures	-		1	ls	$7,500.00	$7,500.00		
	SUBTOTAL							**$214,480.00**	
	Division 2-Existing Conditions								
024000	Demolition								
024213	Deconstructing structure	Deconstruct existing cupola, provide temporary weather protection		3	week	$56,000.00	$168,000.00		
02 42 19	Salvage	Salvage clock faces and mechanism for re-use in new cupola; Salvage intact terracotta pieces for Town		4	days	$5,600.00	$22,400.00		

	SUBTOTAL							**$190,400.00**	
	Division 3-Concrete (not used)								
	Division 4-Masonry								
04 03 00	Maintenance of Period Masonry								
04 03 01.13	Period Masonry Cleaning	Cleaning stonework.		17025	sf	$3.00	$51,075.00		
04 03 05.13	Period Masonry Mortaring	North elevation: Preparing mortar joints, repointing mortar joints - Front Elevation		3670	sf	$60.00	$220,200.00		
	Period Masonry Mortaring	South elevation: Preparing mortar joints, repointing mortar joints - Front Elevation		2380	sf	$60.00	$142,800.00		
	Period Masonry Mortaring	West: Preparing mortar joints, repointing mortar joints - Front Elevation		5675	sf	$60.00	$340,500.00		
	Period Masonry Mortaring	East: Preparing mortar joints, repointing mortar joints - Front Elevation		5300	sf	$60.00	$318,000.00		
04 03 05.71									

04 03 05.91	Period Masonry Rehabilitation	The existing balustrade requires removal down to the bottom rail inclusive of cranes, salvage of the existing balustrade and top rail and clean, Core the bottoms of the balusters to remove existing attachment, cut reglets through the piers to allow for new through wall flashing, core and apply new epoxy-coated bars into the bottom rail and epoxy with Hilti Hy-270 (note: thimbles will have to be made and soldered to the proposed flashing), reinstall the salvaged balustrade and rail.		300	lf of balustrade	$825.00	$247,500.00		
	Period Masonry Restoration	Repair cracked pieces, install Dutchmen, restore anchoring pins		80	ea	$600.00	$48,000.00		
04 72 00									
04 72 00.10	Cast Stone Masonry								
04 72 00.81	Assembly of cupola			20	week	$65,000.00	$1,300,000.00		
04 72 00.85	Laser scan	Existing cupola		1	ls	$27,500.00	$27,500.00		
	Cast stone	molds		150	pcs	$1,250.00	$187,500.00		
	Cast stone	Pieces- limestone color match		500	pcs	$550.00	$275,000.00		

	Cast stone	SS anchors		1	ls	$9,500.00	$9,500.00		
	SUBTOTAL							**$3,167,575.00**	
05 10 00	Division 5-Metals								
05 12 00	Structural Metal Framing								
	Structural Steel Framing	Framing for cast stone cupola		1	ls	$85,000.00	$85,000.00		
05 52 13	pipe railing	repair, paint pipe rail at areaway		1	ls	$1,500.00	$1,500.00		
	SUBTOTAL							**$86,500.00**	
	Division 6-Wood and Plastics (not used)								
07 30 00	Division 7 - Thermal and Moisture Protection								
07 31 26	Steep slope roofing								
07 50 00	Slate shingles	Unfading green slates (5/16 tk), underlayment and fasteners		7800	SF	$55.00	$429,000.00		
07 54 00	Membrane roofing								
	TPO roofing	Vapor barrier, tapered insulation, Dens Deck, fully adhered TPO, copper edge flashing around perimeter		10500	SF	$20.00	$210,000.00		
	TPO roofing - Annex Awning	Vapor barrier, tapered insulation, fully adhered TPO, scupper, metal rim repair, framing repair,		1	ls	$8,500.00	$8,500.00		

		exterior plaster board ceiling, new lighting							
07 60 00									
07 61 13	Flashing and Sheetmetal								
07 61 19	Standing seam metal roofing	Standing seam copper roofs at headhouse and roof		3	ea	$15,500.00	$46,500.00		
07 62 00	Flat seam sheet metal roofing	Flat seam copper roofing on portico roof		120	sf	$50.00	$6,000.00		
	Sheet Metal Flashing and Trim	20 oz Parapet flashing fully locked and soldered with through flashing at parapets.		300	lf x 48"	$825.00	$247,500.00		
	Sheet Metal Flashing and Trim	20 oz, copper wall cap		100	lf x 36"	$675.00	$67,500.00		
	Sheet Metal Flashing and Trim	20 oz, copper gutter		32	lf	$400.00	$12,800.00		
	Sheet Metal Flashing and Trim	Clock tower flashing and flat roof		85	sf	$500.00	$42,500.00		
	SUBTOTAL							**$1,070,300.00**	
	Division 8 - Openings (not used)								
08 01 11.61	Metal Door and Frame Repair	Annex Entries		3	ea	$800.00	$2,400.00		
		Auditorium side aisle exterior doors		2	ea	$600.00	$1,200.00		
		Town Hall Mechanical Room		1	ea	$1,200.00	$1,200.00		

08 01 52.93	Historic Treatment of Wood Windows	Restoration of wood windows on the façade and east and west elevations and south (101 windows) Window unit restoration Frame Restoration Hazardous Material Abatement Frame Painting and Caulking	**Number of windows per type**						
		Window Type A	23	26	sf	$345.00	$206,310.00		
		Window Type B	14	7	sf	$345.00	$33,810.00		
		Window Type C	2	40	sf	$345.00	$27,600.00		
		Window Type E	2	8	sf	$345.00	$5,520.00		
		Window Type F	5	39	sf	$345.00	$67,275.00		
		Window Type G	32	28	sf	$345.00	$309,120.00		
		Window Type O	1	4	sf	$345.00	$1,380.00		
		Window Type H	8	70	sf	$345.00	$193,200.00		
		Window Type I	4	35	sf	$345.00	$48,300.00		
		Window Type J	10	15	sf	$345.00	$51,750.00		
08 03 14	Conservation Treatment for Period Wood Doors	Town hall entry doors		3	ea	$3,000.00	$9,000.00		
		Lyons Meeting Room balcony door reconstruction		1	ea	$8,500.00	$8,500.00		
		Clerks office exterior door and screen		1	ea	$3,500.00	$3,500.00		

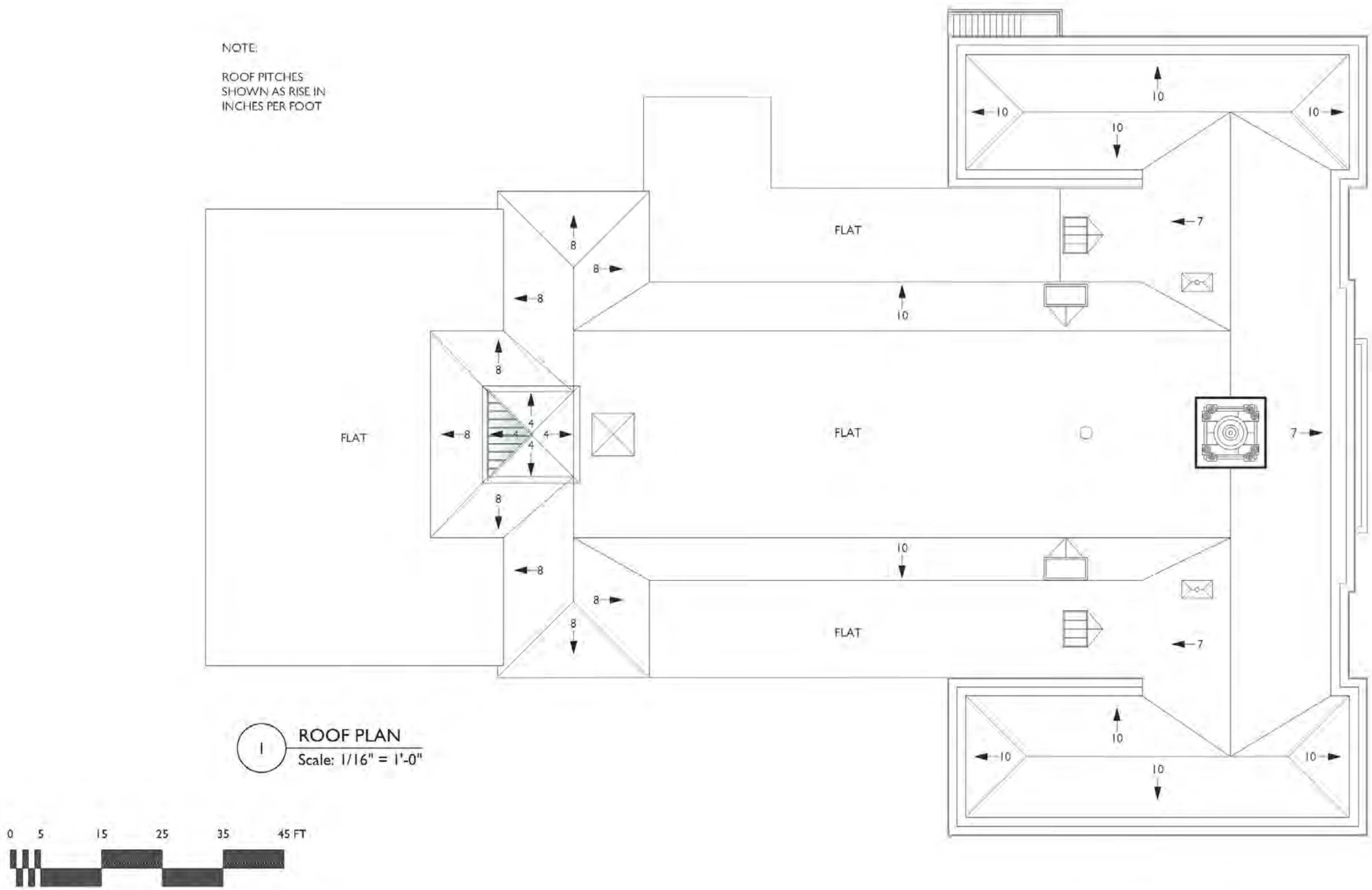
08 51 69.11	Aluminum Two Track Storm Windows - Allied Corporation								
		Window Type A	23	26	sf	$42.50	$25,415.00		
		Window Type B	14	7	sf	$42.50	$4,165.00		
		Window Type C	2	40	sf	$42.50	$3,400.00		
		Window Type E	2	8	sf	$42.50	$680.00		
		Window Type F	5	39	sf	$42.50	$8,287.50		
		Window Type G	32	28	sf	$42.50	$38,080.00		
		Window Type O	1	4	sf	$42.50	$170.00		
		Window Type H	8	70	sf	$42.50	$23,800.00		
		Window Type I	4	35	sf	$42.50	$5,950.00		
		Window Type J	12	15	sf	$42.50	$7,650.00		
08 63 14	Conservation Treatment for Metal Skylights	Town Hall Bathroom Skylights		2	ea	$3,500.00	$7,000.00		
		Stage skylight		1	ea	$7,500.00	$7,500.00		
	SUBTOTAL							**$1,102,162.50**	
	Division 9-Finishes (not used)								
	Division 10 - Specialties (not used)								
	Division 11 - Equipment (not used)								
	Division 12 - Furnishings (not used)								

	Division 13 - Special Construction (not used)								
	Division 14 - Conveying Systems (not used)								
	Division 26 - Electrical (not used)								
Construction Cost before markup									**$5,831,417.50**
	Contractor Profit and Overhead (15%)							$874,712.63	
TOTAL CONSTRUCTION COST									**$6,706,130.13**
	Concept Design Contingency (15%)							$874,712.63	
	Professional Fees (10%)							$583,141.75	
TOTAL PROJECT COST									**$8,163,984.50**
CUPOLA REMOVAL COST									**$368,060.00**
COST WITHOUT CUPOLA REMOVAL									**$7,795,924.50**

DRAWINGS

NOTE:

ROOF PITCHES
SHOWN AS RISE IN
INCHES PER FOOT



ROOF PLAN
Scale: 1/16" = 1'-0"

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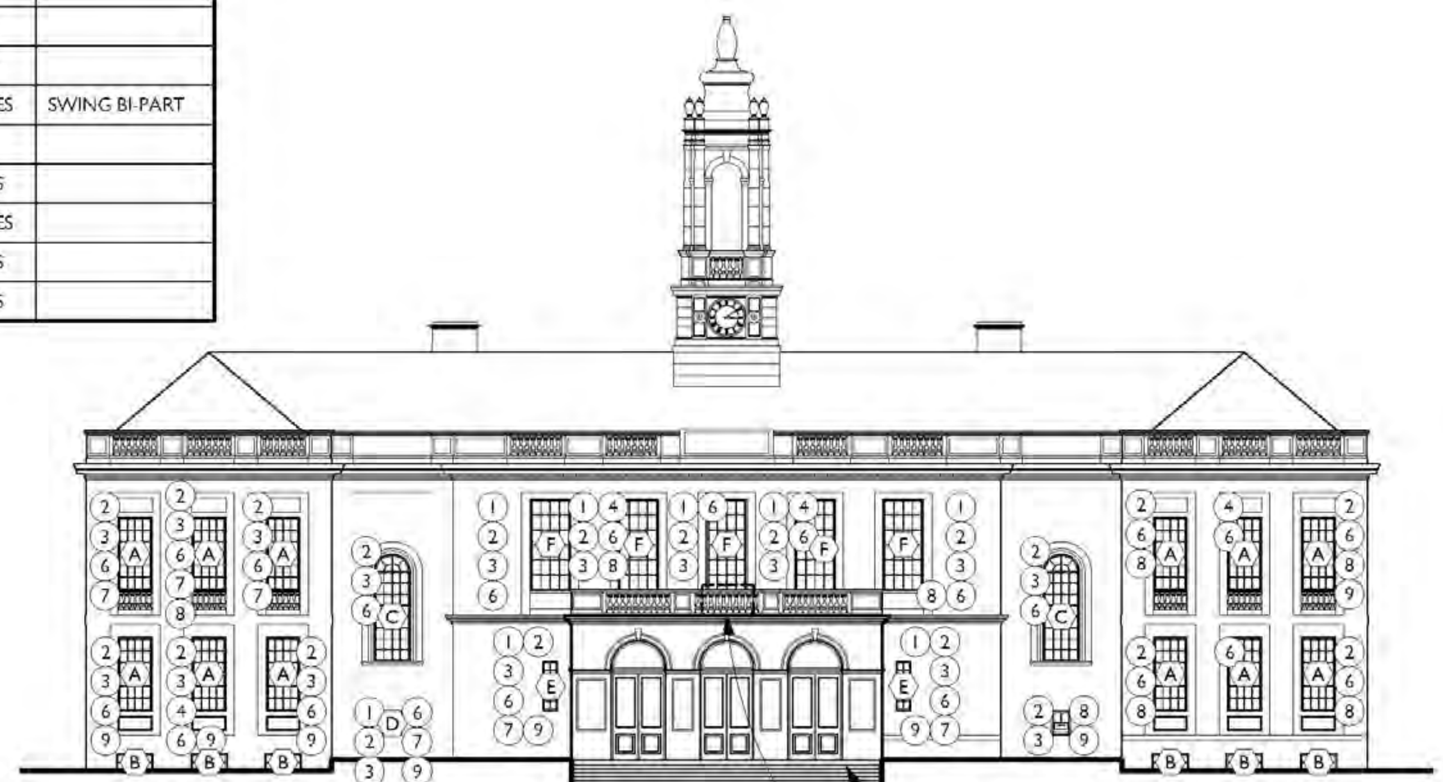
ROOF PLAN
1.0

ROOF PLAN

WINDOW SCHEDULE					
WINDOW TYPE & QUANTITY	R.O. WIDTH	R.O. HEIGHT	R.O. SQ FT.	LITES	NOTES
A (23)	3'-6"	7'-6"	26.25 S.F.	12/12	
B (17)	3'-9"	1'-9 1/2"	6.7 S.F.	8 LITES	
C (2)	3'-9"	11'-0"	39.7 S.F.	6/16/16	ARCHED TOP
D (2)	1'-11 1/2"	2'-6"	4.9 S.F.	2/2	
E (2)	1'-6"	5'-0"	7.5 S.F.	6/6	
F (5)	4'-2"	9'-4 1/2"	39.1 S.F.	12/12	
G (32)	3'-9"	7'-6"	28.1 S.F.	12/12	
H (8)	5'-6"	12'-6"	68.75 S.F.	16/16	
I (4)	4'-6"	7'-6"	33.75 S.F.	20 LITES	SWING BI-PART
J (12)	3'-0"	5'-0"	15 S.F.	6/6	
K (3)	1'-8 1/2"	4'-6 1/2"	7.8 S.F.	3 LITES	
L (20)	12'-6 1/2"	5'-8"	71.1 S.F.	12 LITES	
M (6)	6'-3 1/4"	5'-8"	35.5 S.F.	6 LITES	
N (9)	8'-7 1/4"	5'-8"	50.3 S.F.	9 LITES	

1 NEW STORM
1a ADD STORM
2 PAINT EXTERIOR & TRIM
3 GLAZE
4 NEW SASH CHAIN
5 NEW SASH ROPE
6 REFINISH INTERIOR
7 REFINISH INTERIOR JAMB & SASH
8 BROKEN LITE
9 REPLACE MUNTINS
10 COAT LINTEL STEEL
11 REPLACE RIVETS IN MULLION COVERS
12 REBUILD
13 EXTERIOR TRIM WOOD REPAIR
14 REPLACE CRANKS
15 DG SEALS
16 REPLACE SCREENING
17 REPAIR CASEMENT BOLTS



1 NORTH ELEVATION
Scale: 1/16" = 1'-0"

0 5 15 25 35 45 FT

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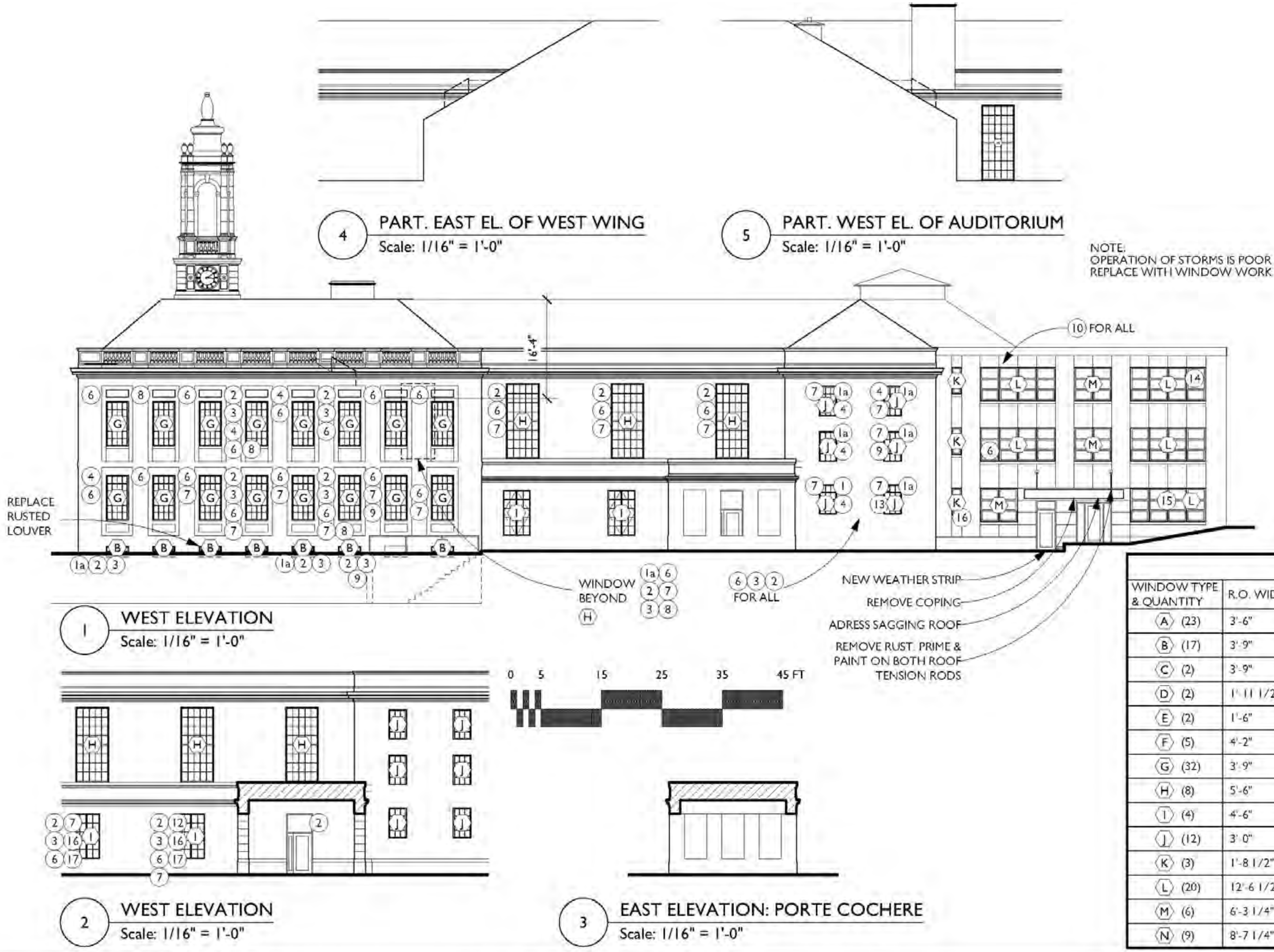
NORTH ELEVATION
1.1
NORTH



1 NEW STORM SEE NOTE: APPLY TO ALL DOUBLE HUNG SASH
1a ADD STORM
2 PAINT EXTERIOR & TRIM
3 GLAZE
4 NEW SASH CHAIN
5 NEW SASH ROPE
6 REFINISH INTERIOR
7 REFINISH INTERIOR JAMB & SASH
8 BROKEN LITE
9 REPLACE MUNTINS
10 COAT LINTEL STEEL
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12 REBUILD
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15 DG SEALS
16 REPLACE SCREENING
17 REPAIR CASEMENT BOLTS

WINDOW SCHEDULE

WINDOW TYPE & QUANTITY	R.O. WIDTH	R.O. HEIGHT	R.O. SQ FT.	LITES	NOTES
A (23)	3'-6"	7'-6"	26.25 S.F.	12/12	
B (17)	3'-9"	1'-9 1/2"	6.7 S.F.	8 LITES	
C (2)	3'-9"	11'-0"	39.7 S.F.	6/16/16	ARCHED TOP
D (2)	1'-11 1/2"	2'-6"	4.9 S.F.	2/2	
E (2)	1'-6"	5'-0"	7.5 S.F.	6/6	
F (5)	4'-2"	9'-4 1/2"	39.1 S.F.	12/12	
G (32)	3'-9"	7'-6"	28.1 S.F.	12/12	
H (8)	5'-6"	12'-6"	68.75 S.F.	16/16	
I (4)	4'-6"	7'-6"	33.75 S.F.	20 LITES	SWING BI-PART
J (12)	3'-0"	5'-0"	15 S.F.	6/6	
K (3)	1'-8 1/2"	4'-6 1/2"	7.8 S.F.	3 LITES	
L (20)	12'-6 1/2"	5'-8"	71.1 S.F.	12 LITES	
M (6)	6'-3 1/4"	5'-8"	35.5 S.F.	6 LITES	
N (9)	8'-7 1/4"	5'-8"	50.3 S.F.	9 LITES	

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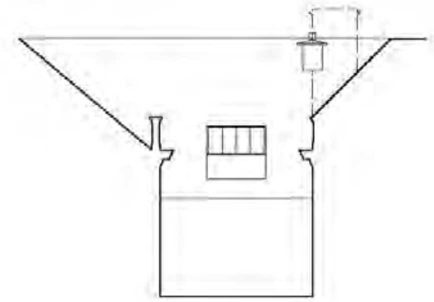
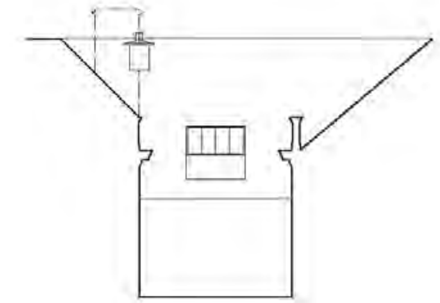
WEST ELEVATION & PORTE COCHERE
1.2
WEST

WINDOW SCHEDULE					
WINDOW TYPE & QUANTITY	R.O. WIDTH	R.O. HEIGHT	R.O. SQ FT.	LITES	NOTES
A (23)	3'-6"	7'-6"	26.25 S.F.	12/12	
B (17)	3' 9"	1'-9 1/2"	6.7 S.F.	8 LITES	
C (2)	3'-9"	11'-0"	39.7 S.F.	6/16/16	ARCHED TOP
D (2)	1'-11 1/2"	2'-6"	4.9 S.F.	2/2	
E (2)	1'-6"	5'-0"	7.5 S.F.	6/6	
F (5)	4'-2"	9'-4 1/2"	39.1 S.F.	12/12	
G (32)	3'-9"	7'-6"	28.1 S.F.	12/12	
H (8)	5'-6"	12'-6"	68.75 S.F.	16/16	
I (4)	4'-6"	7'-6"	33.75 S.F.	20 LITES	SWING BI-PART
J (12)	3'-0"	5'-0"	15 S.F.	6/6	
K (3)	1'-8 1/2"	4'-6 1/2"	7.8 S.F.	3 LITES	
L (20)	12'-6 1/2"	5'-8"	71.1 S.F.	12 LITES	
M (6)	6'-3 1/4"	5' 8"	35.5 S.F.	6 LITES	
N (9)	8'-7 1/4"	5'-8"	50.3 S.F.	9 LITES	

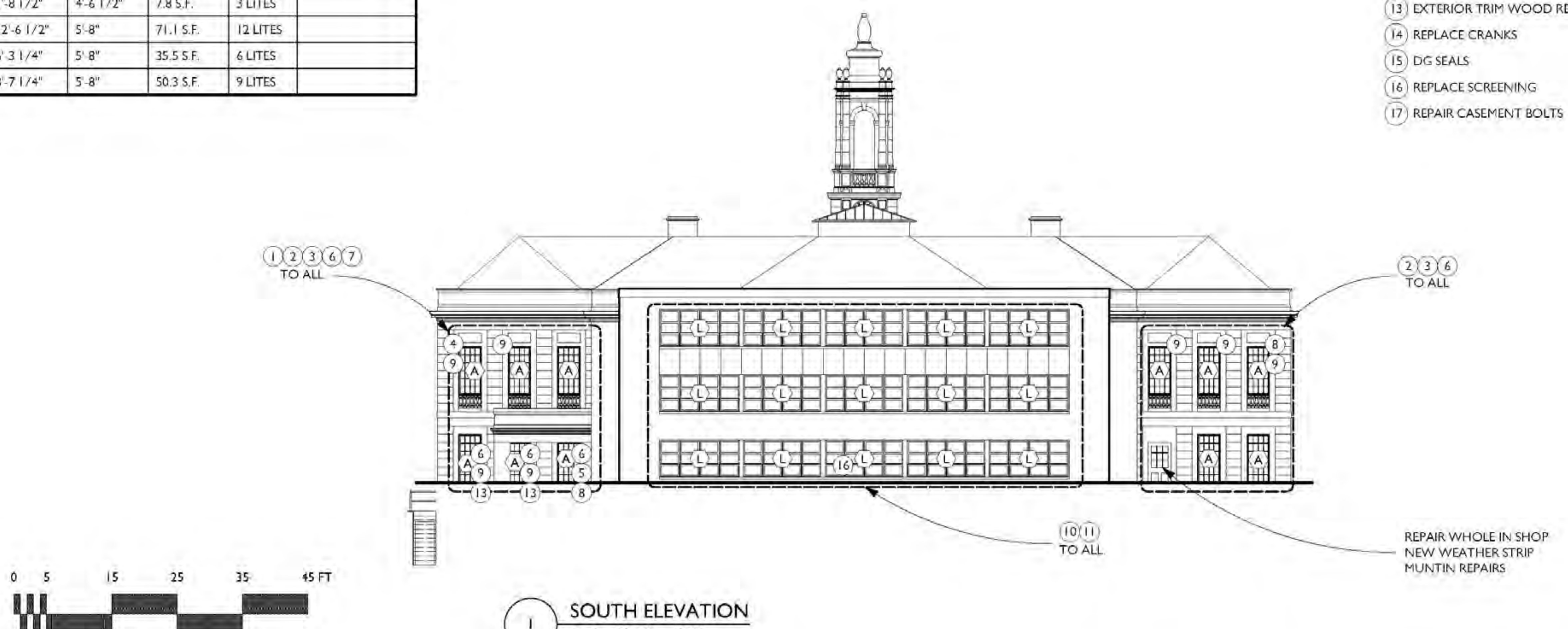


2 SOUTH ELEVATION OF WEST WING
Scale: 1/16" = 1'-0"



3 SOUTH ELEVATION OF EAST WING
Scale: 1/16" = 1'-0"

1 NEW STORM
1a ADD STORM
2 PAINT EXTERIOR & TRIM
3 GLAZE
4 NEW SASH CHAIN
5 NEW SASH ROPE
6 REFINISH INTERIOR
7 REFINISH INTERIOR JAMB & SASH
8 BROKEN LITE
9 REPLACE MUNTINS
10 COAT LINTEL STEEL
11 REPLACE RIVETS IN MULLION COVERS
12 REBUILD
13 EXTERIOR TRIM WOOD REPAIR
14 REPLACE CRANKS
15 DG SEALS
16 REPLACE SCREENING
17 REPAIR CASEMENT BOLTS



1 SOUTH ELEVATION
Scale: 1/16" = 1'-0"

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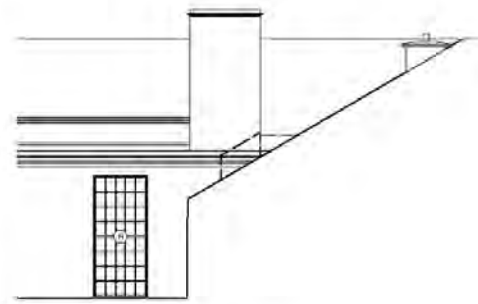
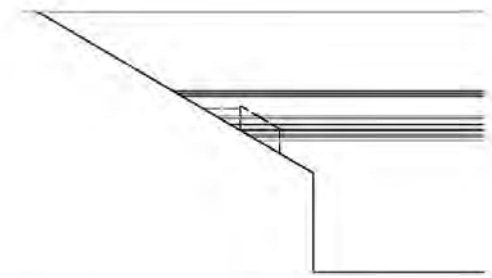
SOUTH ELEVATION
1.3
SOUTH

WINDOW SCHEDULE

WINDOW TYPE & QUANTITY	R.O. WIDTH	R.O. HEIGHT	R.O. SQ FT.	LITES	NOTES
A (23)	3'-6"	7'-6"	26.25 S.F.	12/12	
B (17)	3'-9"	1'-9 1/2"	6.7 S.F.	8 LITES	
C (2)	3'-9"	11'-0"	39.7 S.F.	6/16/16	ARCHED TOP
D (2)	1'-11 1/2"	2'-6"	4.9 S.F.	2/2	
E (2)	1'-6"	5'-0"	7.5 S.F.	6/6	
F (5)	4'-2"	9'-4 1/2"	39.1 S.F.	12/12	
G (32)	3'-9"	7'-6"	28.1 S.F.	12/12	
H (8)	5'-6"	12'-6"	68.75 S.F.	16/16	
I (4)	4'-6"	7'-6"	33.75 S.F.	20 LITES	SWING BI-PART
J (12)	3'-0"	5'-0"	15 S.F.	6/6	
K (3)	1'-8 1/2"	4'-6 1/2"	7.8 S.F.	3 LITES	
L (20)	12'-6 1/2"	5'-8"	71.1 S.F.	12 LITES	
M (6)	6'-3 1/4"	5'-8"	35.5 S.F.	6 LITES	
N (9)	8'-7 1/4"	5'-8"	50.3 S.F.	9 LITES	

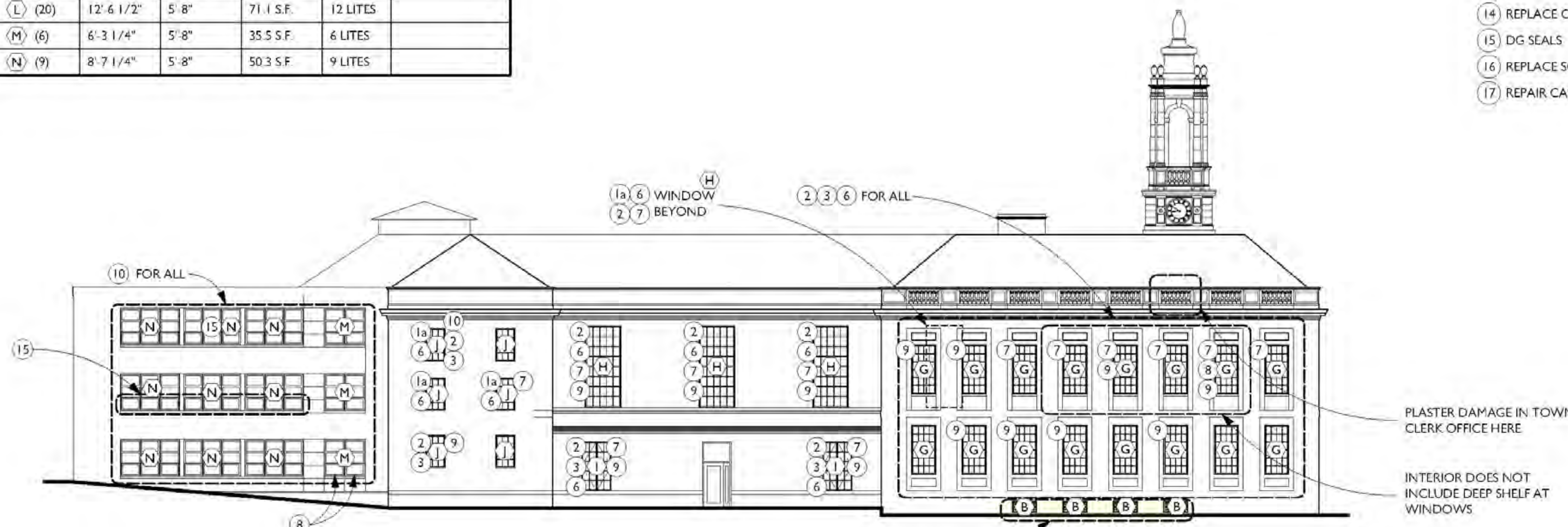


2 PART. WEST EL. OF AUDITORIUM
Scale: 1/16" = 1'-0"



3 PART. EAST EL. OF WEST WING
Scale: 1/16" = 1'-0"

1. NEW STORM
1a. ADD STORM
2. PAINT EXTERIOR & TRIM
3. GLAZE
4. NEW SASH CHAIN
5. NEW SASH ROPE
6. REFINISH INTERIOR
7. REFINISH INTERIOR JAMB & SASH
8. BROKEN LITE
9. REPLACE MUNTINS
10. COAT LINTEL STEEL
11. REPLACE RIVETS IN MULLION COVERS
12. REBUILD
13. EXTERIOR TRIM WOOD REPAIR
14. REPLACE CRANKS
15. DG SEALS
16. REPLACE SCREENING
17. REPAIR CASEMENT BOLTS



1 EAST ELEVATION
Scale: 1/16" = 1'-0"

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EAST ELEVATION
1.4
EAST

APPENDICES

Arlington Town Hall
Exterior Masonry Assessment – draft March 28, 2022

Introduction

In March of 2022, Ivan Myjer of Building and Monument Conservation, working as part of the team led by Patrick Guthrie of Design Associates Inc, surveyed the exterior masonry of the Arlington Town Hall. The survey was conducted from the ground and from the upper flat roof of the building. The purpose of the survey was to evaluate the condition of the exterior masonry and develop a plan for the long-term preservation and maintenance of the building.

Executive Summary

The original portion of the Arlington Town Hall was designed by Richard Clipston Sturgis and completed in 1913. The addition at the rear was built in 1955. Both the original building and the addition are clad with Indiana limestone. The clocktower on the roof of the 1913 building is clad in white glazed terra cotta.

With the exception of the clocktower, the original building and the addition are in good shape structurally. The exterior masonry, however, is suffering from long deferred maintenance. Water is entering the walls through open and failed mortar joints, unprotected upward facing joints and failed flashing and sealants. **(Reference photos 4 & 5)** The limestone units for both the original building and the addition are attached to the back-up masonry with steel anchors. In a few locations, these anchors have rusted as a result of the water infiltration. The expansion of the corroded anchors has cracked and spalled the limestone in the locations where the corrosion is very advanced. **(Reference photo 3)** Reducing water infiltration into walls by repointing the joints and protecting upward facing joints is critical to preventing additional stone cracking and spalling from the expansion of rusting stone anchors.

Limestone is a very porous stone. When it is used at grade moisture that is in the soil around the base of the building or sitting on the hardscape is pulled into the stone through capillary action. Moisture wicking into the stone from the soil around Town Hall is responsible for the staining and discoloration of the limestone that is visible at the base of the building. **(Reference photos 2,11,12)** On the north and west elevations, dissolved deicing salts are being drawn into the stone with the water that is pulled into the stone from the walkways, stone landing and parking lot. When the water that has entered the stone evaporates, the salts recrystallize within the pores of the stone. The expansive force of the salt recrystallization has resulted in significant damage to the stone on the west elevation at the interior and exterior of the porte cochere and around the entrance to addition. **(Reference photos 11 & 12)**

On the west elevation, the stone at the base of the building has also been damaged by the expansive force of water inside saturated units of stone freezing in the winter. **(Reference photo 13)** The optimal solution to the salt and frost problem would be to improve the drainage of water away from the the walls and, if possible, reduce the amounts of salt that is spread on the hardscape. Salt contaminated stone cannot be repaired, the only solution is to replace it with new

units of Indiana limestone. Stone replacement without first correcting the drainage problems at the base of building would result in the rapid deterioration of the new stone.

The limestone units on the rest of the building are in relatively good condition but there are some problems resulting from localized conditions. At the front entrance, the panels below the balcony balustrade are damaged from water flowing off of the balcony and into the open joints of the balcony cornice. **(Reference photo 2)** The limestone panels below the balcony include units with carvings of the state and national seals. Repairing the water infiltration issues at the front of the building is critical to preventing damage to the carvings. The upward facing joints at all of the cornices – not just at the balcony - require repointing and the installation of lead "T" caps over the joints to prevent water from flowing through the joints and into the walls below. **(Reference photos 5 & 6)**

On the west elevation at the northwest corner of the wing, a large cornice unit cracked at some point in the past and was repaired with steel staples installed over the crack on the top surface of the stone. **(Reference photo 5)** These uncoated steel staples have begun to corrode. This condition requires further investigation to determine if the repair is stable. There is a danger that the ongoing corrosion of the steel used in the repair will eventually crack the stone into smaller fragments. We recommend using a lift to look at the conditions more closely if the restoration of the building is not going to take place in the near future. The whole unit will probably have to be replaced at some point but it would be prudent to check the condition and, if necessary, stabilize the unit for the short term.

The roof level balustrade units on the front and east and west returns of the 1913 building are in relatively good condition. On two of the bays on the front elevation, most of the balusters in those two sections are cracked either at the top or the bottom or in some cases at both ends. This type of cracking is usually a sign that the units were pinned together with mild steel pins that have begun to corrode. **(Reference photo 10)**

Bronze cramp anchors set in small kerfs cut into the stone are visible at the top of the balustrade coping units. Since most of the balusters do not exhibit cracking, it is likely that bronze pins were used to secure these units to each other. The cracks in the balusters at the front of the building may be an indication that steel pins were substituted for bronze in some locations. When the balustrade on the front and sides is removed to replace the deteriorated roof flashing, all of the individual stone units should be checked for steel pins. Cracked or broken balusters will have to be replaced with new limestone units and all steel pins will have to be removed and replaced with stainless steel or another type of non-corrosive pin.

Biological films have colonized the surface of some sections of the stonework. **(Reference photos 5 & 6)** The films appear very dark when they are dry and slightly greenish when they are wet. Removing the films is not difficult but preventing them from returning in only a few years in close to impossible.

Terra Cotta Clock Tower

The clock tower is a somewhat independent section of the 1913 building. Unlike the rest of the building, which is clad in Indiana limestone, the clocktower is clad with terra cotta – a material that was relatively new in 1913 when the clocktower was constructed. Architectural terra cotta units are made from clay that has been formed in a mold and fired to a high temperature in a kiln. After the first firing, the units are coated with a glaze and then fired a second time to vitrify the glaze and bond it to the substrate. To reduce weight, and prevent cracking of the clay as it dries, all but the very smallest units were made hollow. The individual units are connected to the building, and to each other, with steel pins, dowels and rods which in turn are connected to angles, channels, and small I- beams that are embedded in the masonry. In the thinner sections of the wall, the terra cotta units comprise the entire wall. In the thicker sections, the terra cotta units were placed over hollow clay tiles, brick masonry or cast concrete walls. **(Reference Photo 21 for typic connection details for terra cotta towers)**

Unlike limestone, terra cotta is very strong and is not subject to deterioration from acid rain. Terra cotta assemblies however have several weaknesses. The entire system deteriorates when water infiltrates the assemblies through unmaintained joints. The glazes on the exterior surfaces prevent water that has entered the system to evaporate through the surface of the units. Water that remains in the chambers corrodes the steel anchors and soaks into the exposed clay bisque on the interior. If the water that is trapped within the clay bisque freezes, the bond between the exterior glaze and the clay substrate breaks and the glazes begin to flake off. When the glaze begins to fail, water enters the unprotected clay bisque through the face of the unit and the process of glaze loss accelerates. Occasionally, the amount of water trapped in a unit is so great that when the temperature drops below freezing, the units are cracked by the expansive force of the water turning into ice. Cracked units of terra cotta can represent a safety hazard to the public if cracked sections detach from the parent unit.

The clocktower is exhibiting several types of advanced deterioration. Many of the terra cotta units are cracked – some in several locations. **(Reference photos 19 & 20)** The exposed portions of the concrete walls are cracking and spalling from the corrosion of the steel reinforcement located in the concrete. **(Reference photo 17)** There is widespread glaze failure and spalling of the exposed clay. **(Reference photo 20)** The steel reinforcing at the roof of the belfry is corroding. **(Reference photo 18)** One of the two urns on the northwest corner has a large crack.

Unfortunately, the clocktower has deteriorated beyond the point of repair. Due to the manner in which terra cotta structures were built with steel supports and anchors buried inside the structure, it is not possible to reach and repair or replace the steel without cutting the terra cotta to expose the steel. At this point in time, the only option is to replace the clocktower either with new terra cotta or another material that closely resembles terra cotta. The least expensive solution would be to replace the clocktower with a new structure clad in a thin shelled material such as Glass Fiber Reinforced Plastic (fiberglass) or Glass Fiber Reinforced Concrete (GFRC). The most expensive solution would be to replace the clocktower with new terra cotta or cast stone.

Given the amount of cracking that is visible, and the life safety issues that arise from the possibility of a fragment of terra cotta detaching, we recommend documenting the existing

structure with a laser scan and then removing it sooner than later even if the fund for replacing it are not currently available.

Summary of Exterior Masonry Conditions

Limestone Walls

1. Open and failing mortar joints.
2. Repointing with a mortar that was too hard and/or not permeable enough for limestone.
3. Failing sealants – especially at copper flashing and the upward facing joints of the cornice.
4. Advanced stone weathering from water infiltration into open mortar joints.
5. Spalling of limestone units as a result of the corrosion and subsequent expansion of steel anchors.
6. Cracking and spalling of baluster units either as a result of the corrosion and subsequent expansion of steel pins between the units or water collecting in the holes where the pins are located and corroding.
7. Shifting of units – especially at the chimneys as a result of ice jacking in the open joints.
8. Advanced deterioration of limestone units at grade resulting from salt crystallization damage.
9. Staining and discoloration of limestone units resulting from rising damp.
10. Frost damage to units are saturated as a result of ice melting during the day and refreezing at night.
11. Discoloration of limestone from living and dormant biological films that have colonized the upward facing surfaces of the stone.
12. Differential erosion of mortar joints resulting from the geometry of the building and streams of water being repeatedly channeled over the same locations.
13. Cracking resulting from prior repairs to the stone using uncoated steel pins and anchors. This condition exists at a large cornice unit on the west elevation.
14. Failure of prior repairs made to the limestone on the west elevation as a result of salts and frost.

Terra Cotta Clock Tower

1. Cracking of terra cotta units as result of the corrosion and expansion of steel anchors or reinforcement.
2. Cracking of terra cotta units resulting from water freezing in the hollow chambers of the units.
3. Cracking of the concrete back up masonry as result of the corrosion and expansion of steel reinforcement.
4. Open and failed mortar joints and sealant joints.
5. Glaze flaking and spalling.

Recommendations for Exterior Masonry:

Limestone Walls

1) Check the condition of the cracked cornice unit on the west elevation up close to evaluate the condition of the corroding steel anchors used to repair the stone. Stabilize, or remove, the damaged unit if it appears that the stone is cracking as a result of the corrosion of the metal staples used in the repair.
2) Evaluate changing the pitch of the hardscape on the west elevation to reduce water infiltration into the base of the wall.
3) Evaluate reducing the amount of salt used on the hardscape in the winter to melt snow and ice.
4) Evaluate using another type of stone when repairing the damaged limestone at the base of the porte cochere. Granite is significantly less porous than limestone and is commonly used at grade.
5) 100% repointing of exterior walls in phases.
6) Installation of lead T caps at all upward facing mortar joints that are not protected by flashing.
7) Disassembly and reassembly of balustrade in conjunction with roof flashing re-detailing. Removal of ferrous metal pins from limestone units and replacement with stainless steel pins. Replacement of cracked or broken balusters.
8) Removal of corroded steel anchors where the stone has spalled as a result of the corrosion followed by installation of new stainless steel anchors and repair of the damaged units with a new piece of limestone cut to fit the area of loss.
9) Removal of damaged cornice unit on the west elevation that was previously repaired with steel pins followed by replacement with a new matching limestone unit.
10) Repair of small areas of loss in the stone with stone repair mortars that are formulated for the repair of limestone.
11) Limited repair to damaged limestone on the west elevation at grade.
12) Repairs to damaged limestone at the interior and exterior of the Porte Cochere with new replacement limestone units and patching of small areas of loss.

Terra Cotta Clock Tower

1) If the tower cannot be removed in the near future then evaluate either a controlled removal of cracked pieces of terra cotta and/or covering the front of the tower with a material such as metal mesh to prevent the possibility of any fragments falling from the tower to the street.
2) Document the existing structure with a laser scan to make it easier to recreate the ornament and the overall appearance of the tower in the future.
3) Remove tower and cap opening in roof to prevent water infiltration.
4) Replicate tower in terra cotta or another material such as fiberglass or cast stone.

Photo 1: North elevation of Town Hall with Indiana limestone exterior and terra cotta clocktower.

Photo 2: Water flowing from the balcony roof through the open joints at the top of the cornice is entering the wall and causing the deterioration of the ashlar units between the above the arches.

Photo 3: Moisture containing dissolved deicing salts is being pulled into the stone from the granite plaza at the base of the north elevation.

Photo 4: Moisture wicking up from the ground on the west elevation has discolored the stone and caused the anchor securing the stone to the backup masonry to corrode. The expansive force of the corroding steel has spalled the stone below the sill.

Photo 5: The cornice unit at the corner of the wing on the west elevation cracked at some point in the past. The crack was repaired with four or five steel staples that bride the crack and the joint. The steel staples are rusting and possibly re-cracking the stone. This unit requires additional investigation.

Photo 6: The upward facing joints on the parapet are protected by the copper gutter but the upward facing joints on the cornice are unprotected. The face and top of the cornice are stained from biological films colonizing the weathered stone.

Photo 7: Water flowing through the open joints at the top of the cornice is responsible for the staining and deterioration of the ashlar units below the cornice.

Photo 8: The mortar in the chimney joints is completely failed. The coping units have shifted slightly as a result of water freezing in the open joints. The brick joints inside the chimney are in need of repointing.

Photo 9: Bronze anchors were used to secure the balustrade coping stone to each other.

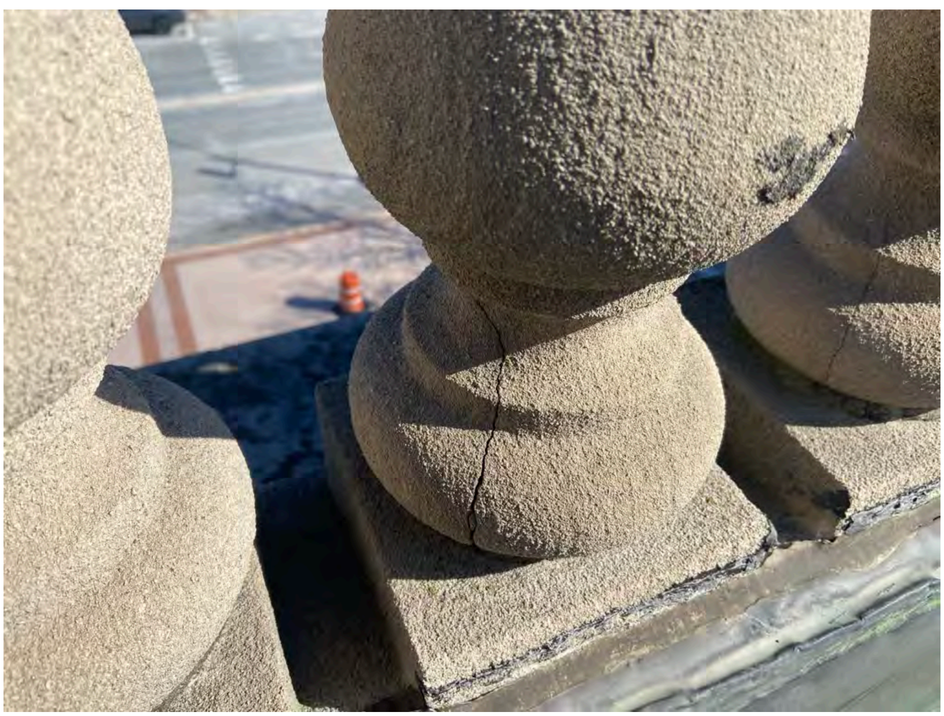


Photo 10: Individual balusters in two bays on the north elevation are cracked at the top and bottom. The cause of the cracking is most likely the corrosion of steel pins used to secure the balusters in place.

Photo 11: The limestone units on the interior of the porte cochere are stained and damaged from water infiltration at the top and bottom of the low wall. Some of the units were repaired in the past. The earlier repairs have reached the end of their service life.

Photo 12: The stonework at the base of the west elevation is stained from moisture wicking into the stone from the parking lot asphalt. The edges of the stone units at the ledges appear to be damaged from frost.

Photo 13: The corner unit at the base of the wall is fractured as a result of frost damage.

Photo 14: South elevation of the addition. The limestone panels are in good condition but the mortar joints are severely eroded.

Photo 15: Water flowing off the edge of the sill is responsible for the deterioration of the vertical mortar joint below the corner of the sill.

Photo 16: The terra cotta clocktower appear to be in relatively good condition when viewed from a distance but when it is viewed up close the problems are very visible.

Photo 17: The concrete frame inside the clocktower is cracked from the expansion of the corroded steel reinforcement inside the concrete.

Photo 18: The steel frame that supports the belfry roof is rusting. Corrosion at the buried ends of the steel members is cracking and displacing the terra cotta.

Photo 19: The top surface of the terra cotta sill units and the adjacent jamb are cracked in several locations.

Photo 20: The terra cotta units at the northeast corner are cracked on both faces of the corner.

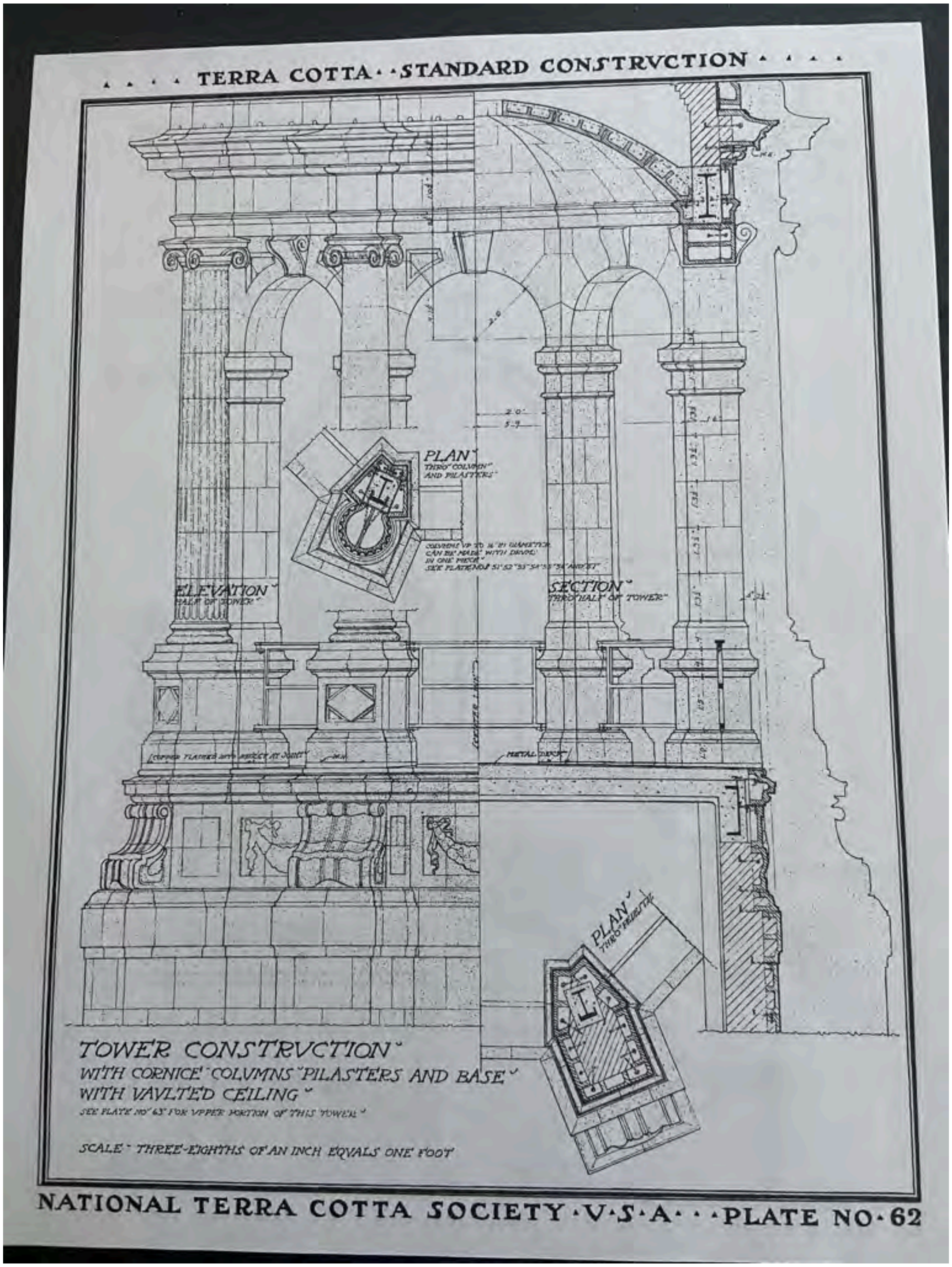


Photo 21: Standard detailing of joints and connections for a terra cotta clocktower similar to the one on the top of the Arlington Town Hall.

Silman

Structural Engineers

111 Devonshire Street
Boston, MA 02109
617 695 6700
silman.com

Date:	11/24/21	Date on site:	11/16/2021
Attention:	Jim Feeney	Project name:	Arlington Town Hall Clock Tower Investigation
Company:	Town of Arlington	Silman project #:	20578
Report:	Existing Conditions Assessment	Location:	Arlington Town Hall
Owner:	Town of Arlington	Present at site:	Jim Feeney
Submitted by:	Mike Laracy	cc:	Mike Auren

BACKGROUND

Silman was retained by the Town of Arlington to observe the structural conditions of the town hall clock tower located at 730 Massachusetts Avenue, Arlington, MA. No existing structural drawings were made available to Silman prior to our visit. Silman has requested that if a copy of these drawings be located that they be passed on to our office for review. During the site visit Silman observed limited existing architectural drawings that were hung along the walls of the building. Based on these drawings and observations in the field, it appears the clock tower framing consists of a steel frame clad infilled with terra-cotta and clad in stone. The tower itself appears to be supported on (4) four steel wide flange beams within the attic space that span to brick masonry bearing walls. On top of these members sit four steel wide flange grillage beams that run diagonal to the supporting beams below. These grillage beams support four double angle columns that extend up to the top of the clock tower. Above this support steel are two additional framed levels, one to access the clocks, and the other acting as a flat roof over the clock tower room. A higher peaked roof exists over this lower flat roof area. Both lower levels are similarly framed with four concrete encased steel members framing between the columns, and a cast in place concrete slab spanning to these members. See Figure 1 for the typical layout of structure overlaid on an elevation from the existing architectural drawing. SSK-1 in the appendix of this report also shows a schematic layout of the structural framing at each level.

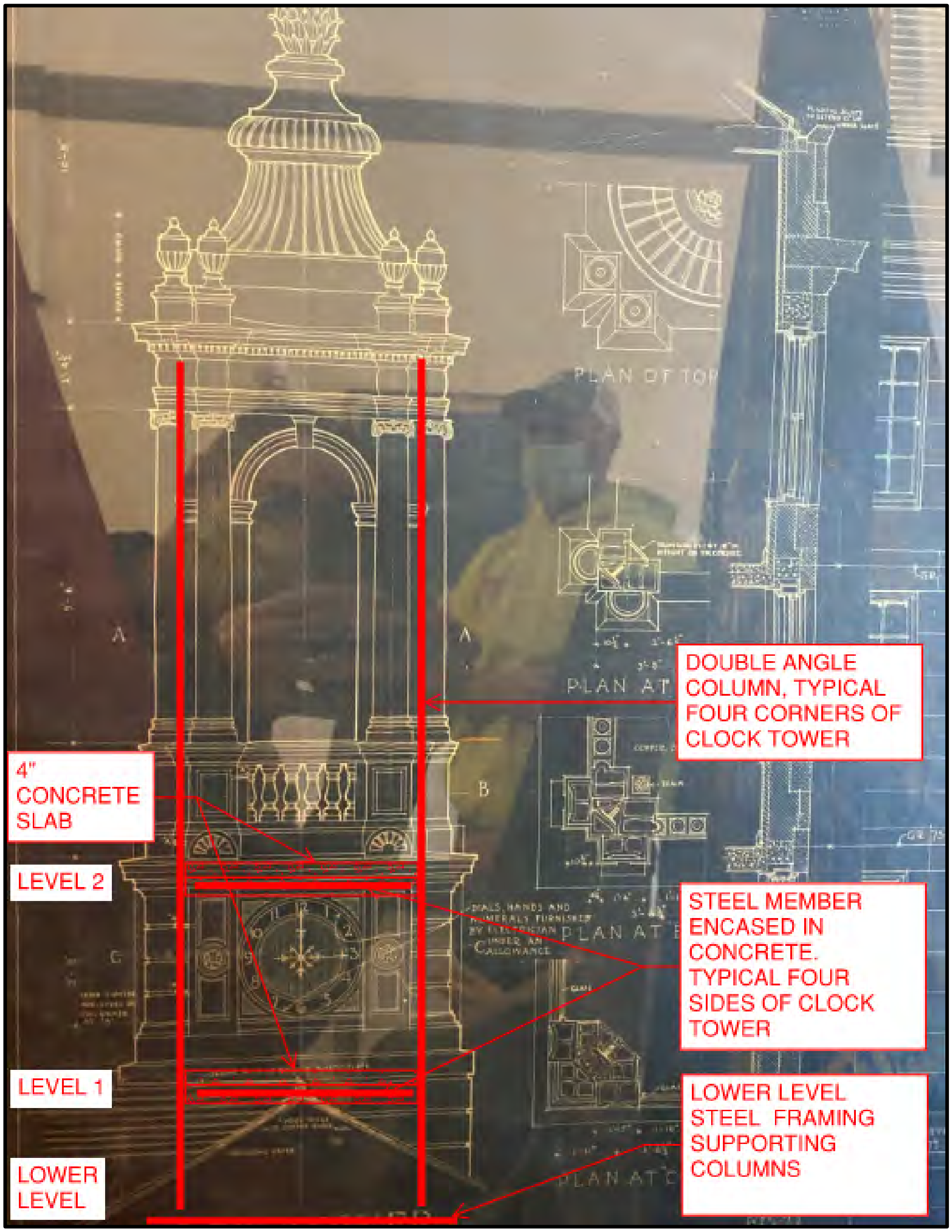


Figure 1 Structure within the clock tower overlaid on a photo of an existing architectural drawing.

INVESTIGATION

Mike Laracy of Silman visited the site on 11/16/2021 to observe the clock tower. Silman did not conduct any destructive probing during the site visit. During the site visit, Silman noted the following:

Interior Observations

<u>Item 1.0</u>

The lower level beams supporting the clock tower were accessed from a wood platform built up over the ceiling joists. This platform had standing water on it (see figure 2). This platform is located directly above the meeting room where water damage is visible on the finished ceiling below. Based on conversations with Jim Feeney and review of photos and videos that were sent to our office prior to our site visit, we understand that water pours through a light fixture in the ceiling directly below this area during moderate to heavy rain events. The steel supporting beams, grillage beams, and columns all appear to be in good condition at this level with some minimal surface rusting present on some members.

Figure 2 On left, a photo taken from the attic space showing the beams supporting the clock tower. The deep girder on the far side of the clock tower is not visible here. On right, water is visible on the wood platform.

The concrete encased steel beams spanning to the columns and supporting the level 1 platform above appear to be in good condition with no signs of rust staining, cracking, or spalling of the concrete encasement.

Figure 3 The concrete encased members supporting the level 1 concrete platform appear to be in good condition.

Item 1.1

At the level 1 platform, the 4" cast in place concrete slab appears to be in good condition from both the underside and top. The double angle columns are clad with terracotta at the interior space between level 1 and level 2 (see figure 4). The majority of the columns are concealed by the terracotta but a small opening at one of the columns revealed significant corrosion of the member (see figure 5).

The concrete encased steel beams spanning to the columns and supporting the level 2 platform are in poor condition. Rust staining is visible on the underside of the concrete, as well as cracking and spalling of the concrete encasement. Silman removed a piece of the spalling concrete from one of the beams and observed significant corrosion of the member (see figure 6). Similar cracking and spalling of the concrete encasement is visible at the other three beams, indicating these members are likely corroding as well. We were unable to ascertain the size or shape (i.e. wide flange, channel or angle) of the steel members in this area based on the limited exposure

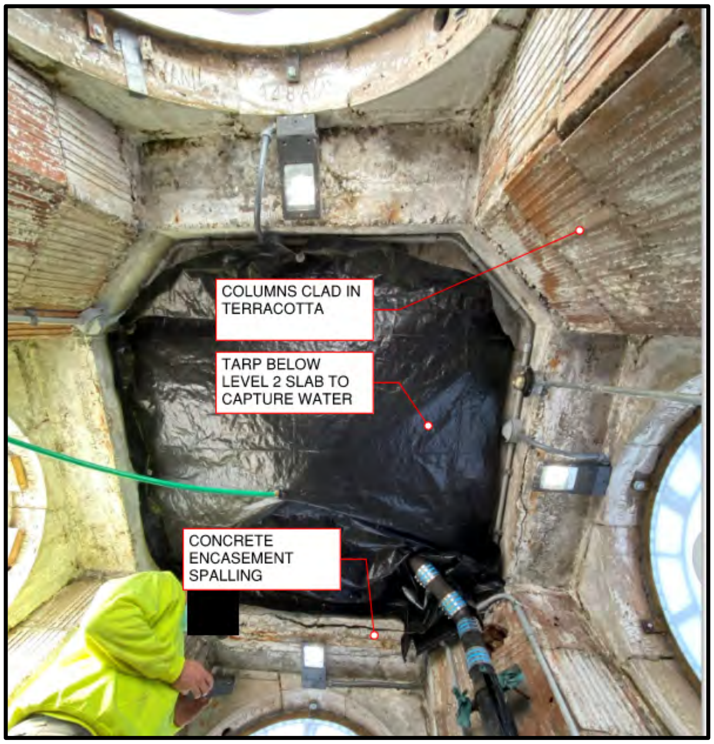


Figure 4 Photo taken looking up at the underside of the level 2 platform.

Figure 5 An opening in the terracotta revealed significant corrosion of the double angle column.

Figure 6 A piece of concrete encasement was removed from the beam to expose the significant corrosion of the member.

Exterior Observations

Item 2.0

The exterior of the clock tower is clad in stone. Weathering and deterioration of the mortar joints between the stones was visible on all sides of the clock tower. Vegetative growth was also visible in some of these joints (see Figure 7).

Figure 7 Deterioration of mortar joints and vegetative growth was visible on all sides of the clock tower.

Item 2.1

The stone cladding around the double angle columns is cracking and the vertical joints between the stones are opening up (see figure 8). Based on earlier stated observations at the interior, this is likely due to corrosion of the columns leading to rust jacking of the stones.

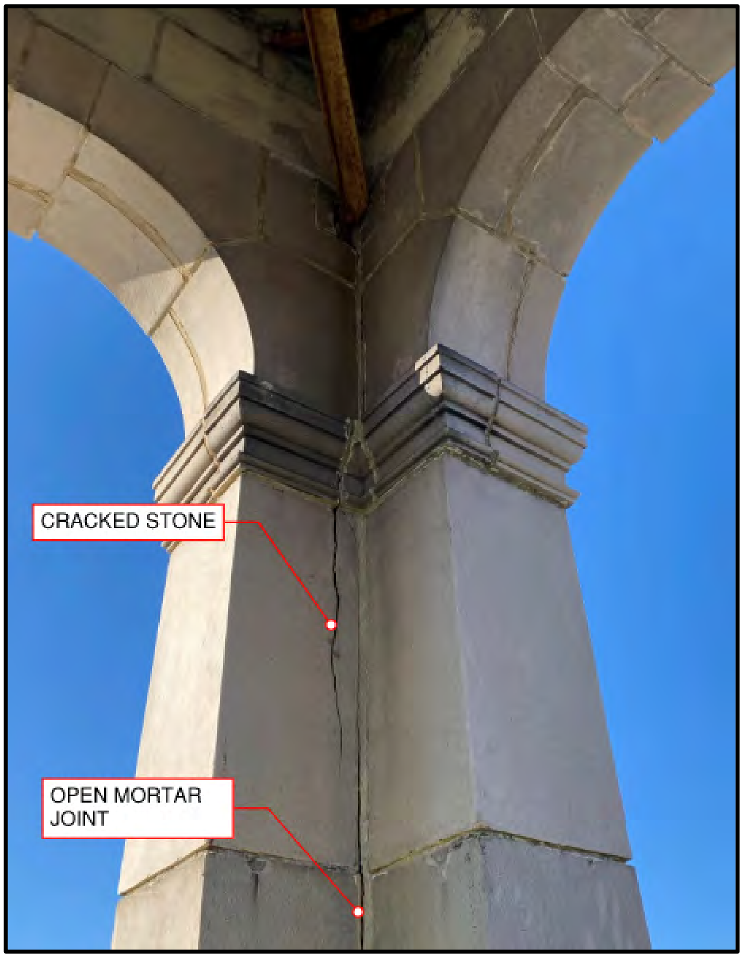


Figure 8 The stone cladding around the column is cracking and the vertical joints between the stones are opening.

Item 2.2

The roof of the clock tower appears to be constructed of a stone flat vault with a circular metal tension ring around its perimeter and a frame of angles spanning to the double angle columns providing additional support at the apex of the vault (see figure 9). Surface rusting of the angles and tension ring was visible.

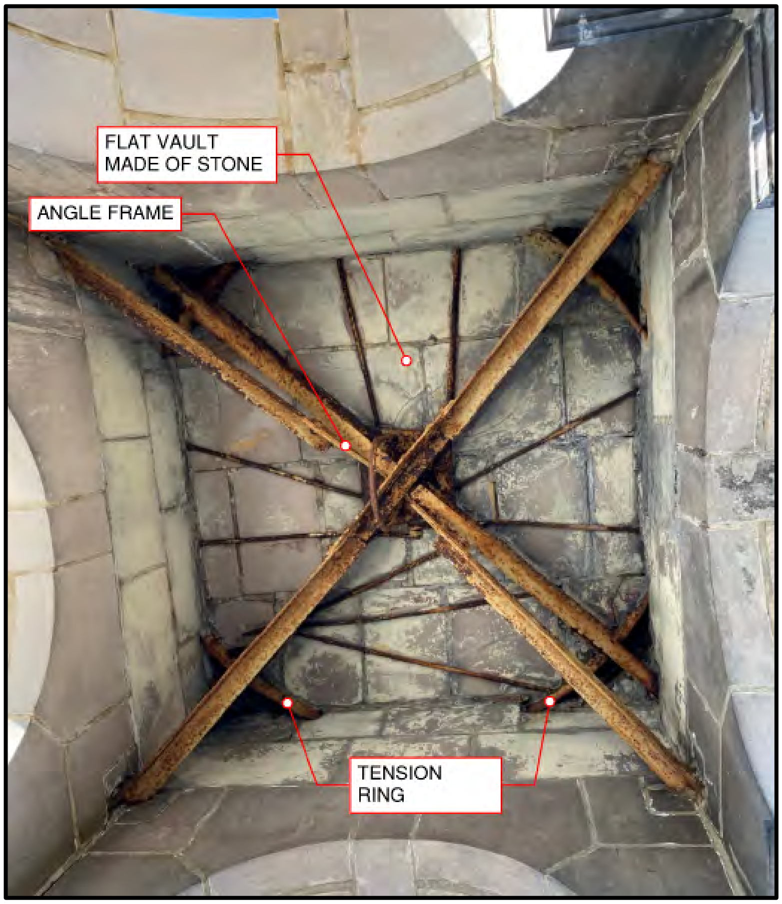


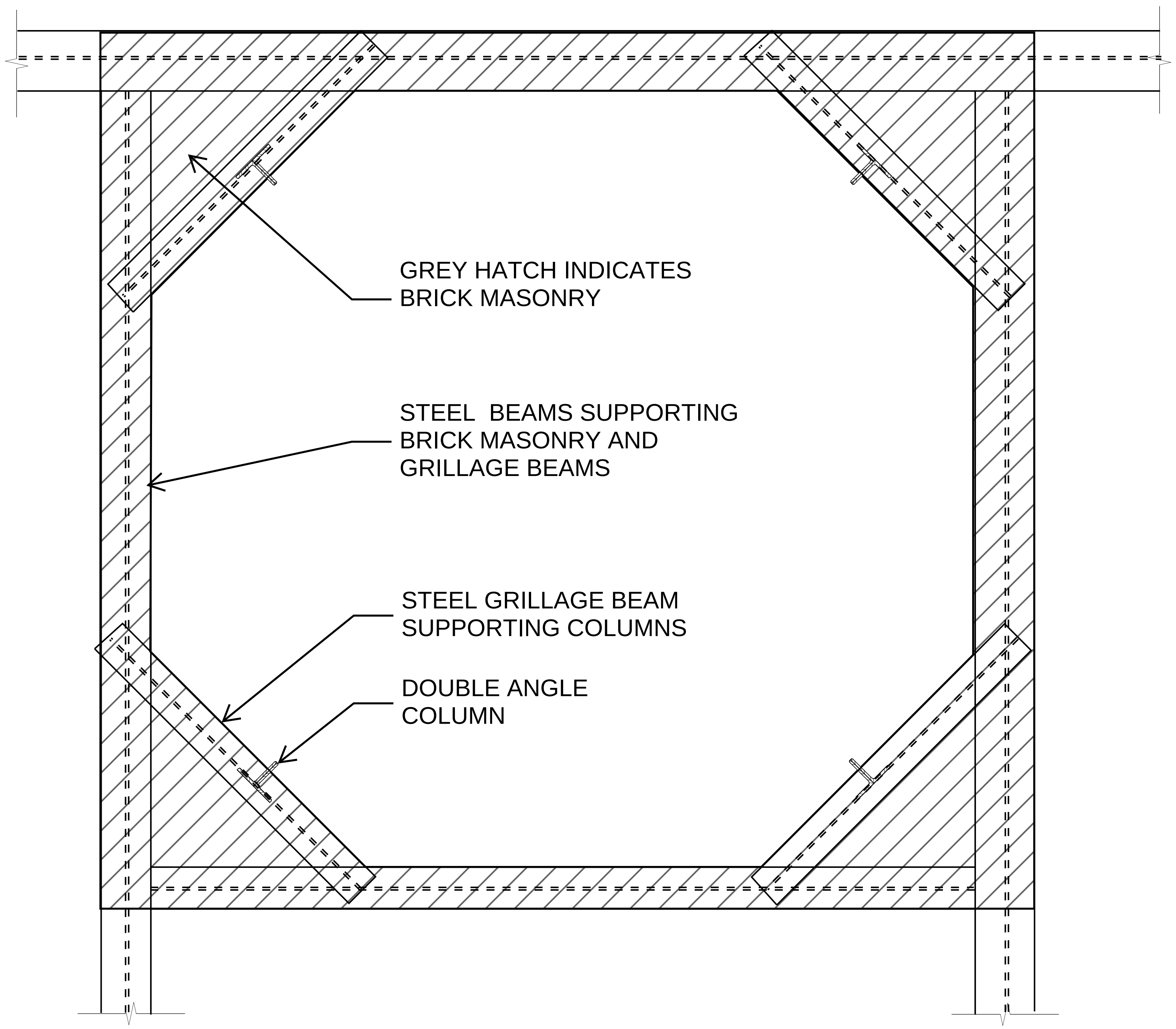
Figure 9 The angles and tension ring supporting the stone flat vault are showing signs of surface rusting.

CONCLUSION

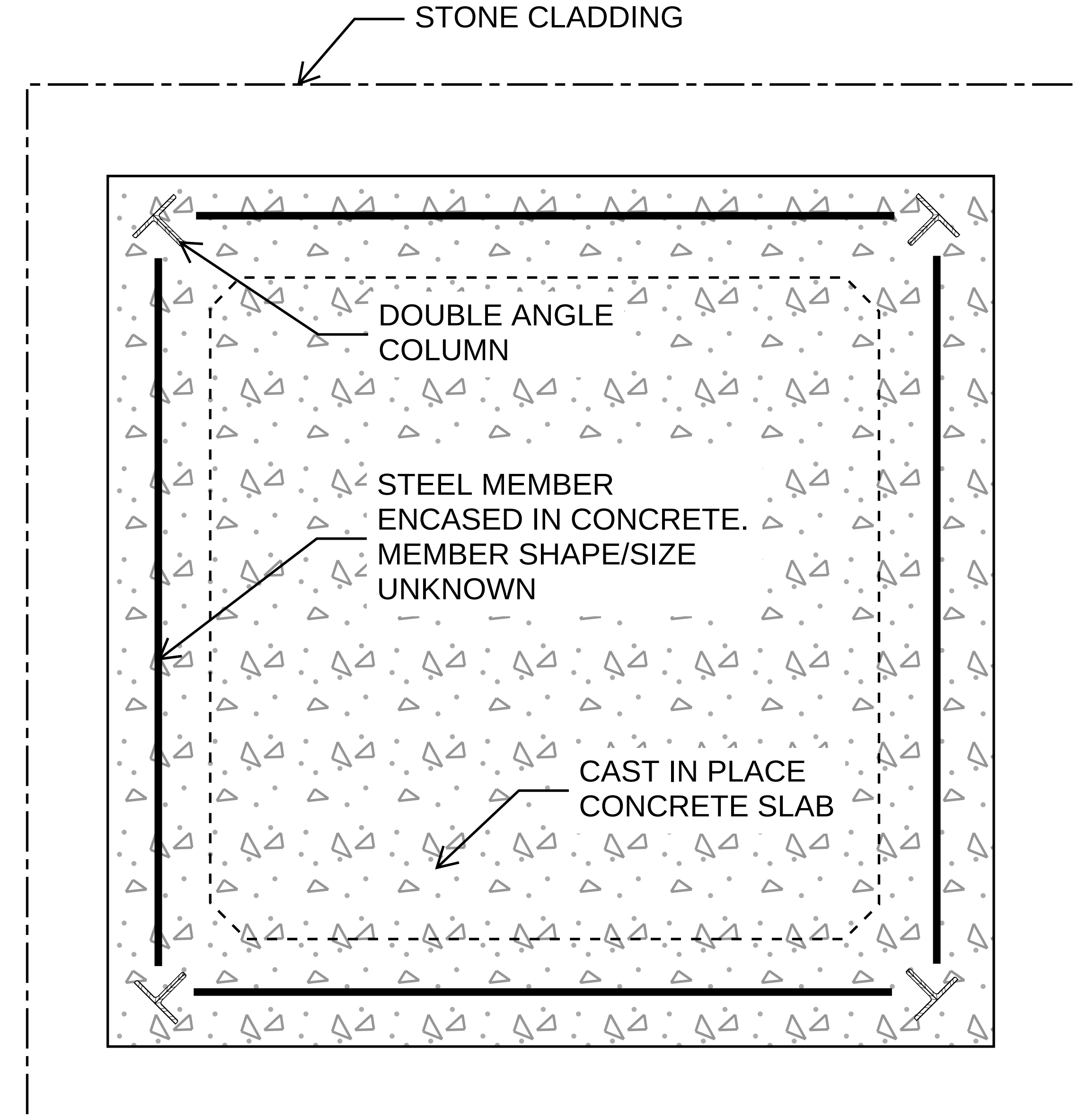
Based on Silman's observations during their 11/16/21 site visit, it is recommended that a more comprehensive investigation be undertaken so that the full extent of the damage can be ascertained, and repair recommendations can be made. This investigation may necessitate the removal of small areas of concrete encasement, terracotta and stone cladding to expose all structurally compromised steel members above the level 1 platform to better understand the extent of the damaged steel in order to facilitate creation of repair documents. The anticipated repairs will likely include some combination of scraping and painting (at minor deteriorated areas), adding supplemental plating (at more aggressive section loss areas), and or replacement of members that have lost their structural integrity. They will also likely require exterior maintenance - repointing of stone joints, and new waterproofing details to prevent future water ingress at the clock tower and exterior restoration of the stone. These items will be part of the architectural recommendations, and based on the observation report to be provided by Design Associates.

In the short term, Silman recommends that the level 2 beams that are corroding and causing the concrete encasement to spall, be temporarily shored down to the level 1 structure below. The intent of this shoring to help mitigate the sag over the clock faces as seen from the exterior, and likely being caused by loss of steel section in the supporting members. It is not intended to arrest further deterioration. It should be noted that these members are aggressively corroding, and as this condition continues to worsen over time, further rust jacking of the concrete encasement may cause the exterior stones to be displaced.

Please contact us should you have questions or concerns related to the report content.



LOWER LEVEL PLAN
N.T.S.



LEVEL 1 AND LEVEL 2 PLAN
N.T.S.

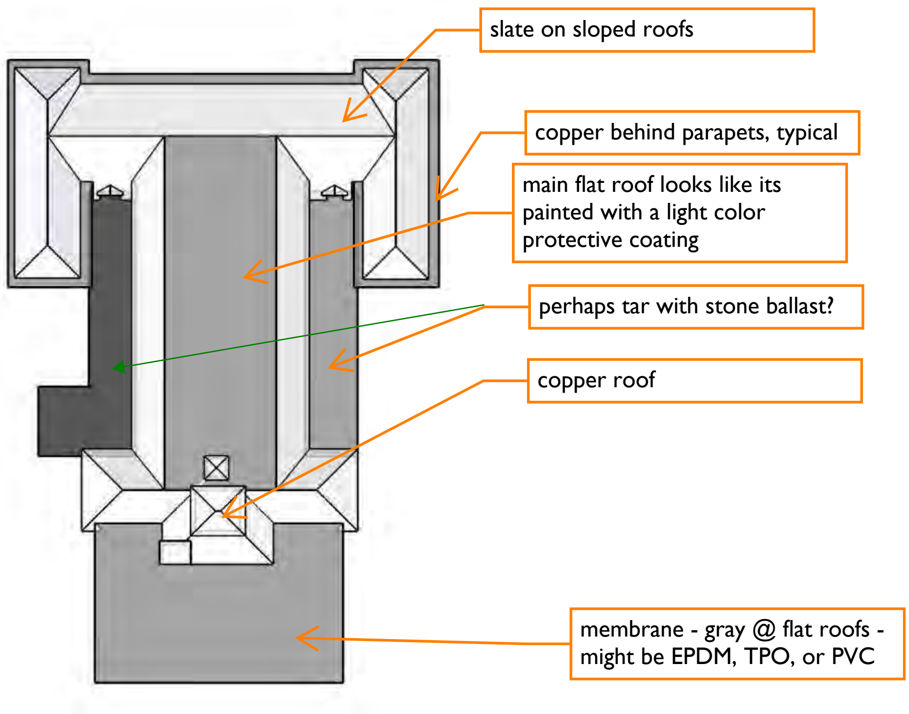
Title: SCHEMATIC FRAMING PLANS AT CLOCK TOWER

Silman
111 Devonshire Street, Boston, MA 02109
617 695 6700

Job Number:	20578
Job Title:	ARLINGTON TOWN HALL CLOCK TOWER INVESTIGATION
Date:	11/23/2021
Scale:	NTS
Reference:	REPORT APPENDIX

SSK-1

730 Massachusetts Ave, Arlington, MA 02476-4906



In this 3D model, facets appear as semi-transparent to reveal overhangs.

Report Details

Report: 43980726

Roof Details

Total Roof Area = 20,909 sq ft
Total Roof Facets = 42
Predominant Pitch = 0/12
Number of Stories >1
Total Ridges/Hips = 488 ft
Total Valleys = 203 ft
Total Rakes = 42 ft
Total Eaves = 1,177 ft
Total Penetrations = 39
Total Penetrations Perimeter = 494 ft
Total Penetrations Area = 699 sq ft

Report Contents

Contact: Patrick Guthrie
Company: Design Associates, Inc
Address: 1035 Cambridge St
Cambridge MA 02141-1057
Phone: 617-661-9082

Measurements provided by www.eagleview.com

Certified Accurate

www.eagleview.com/Guarantee.aspx

Images

The following aerial images show different angles of this structure for your reference.

North Side

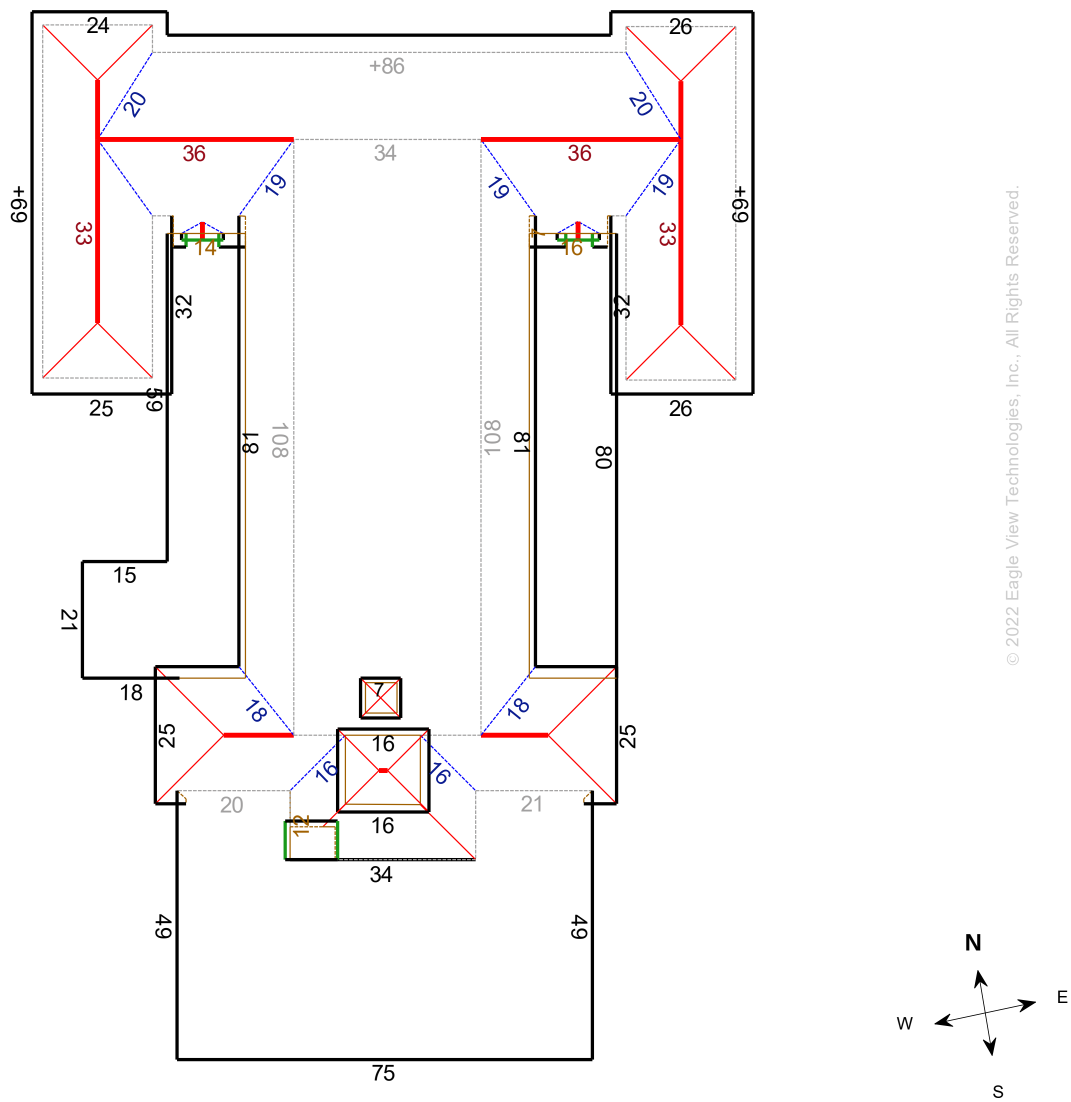
South Side

East Side

West Side

Length Diagram

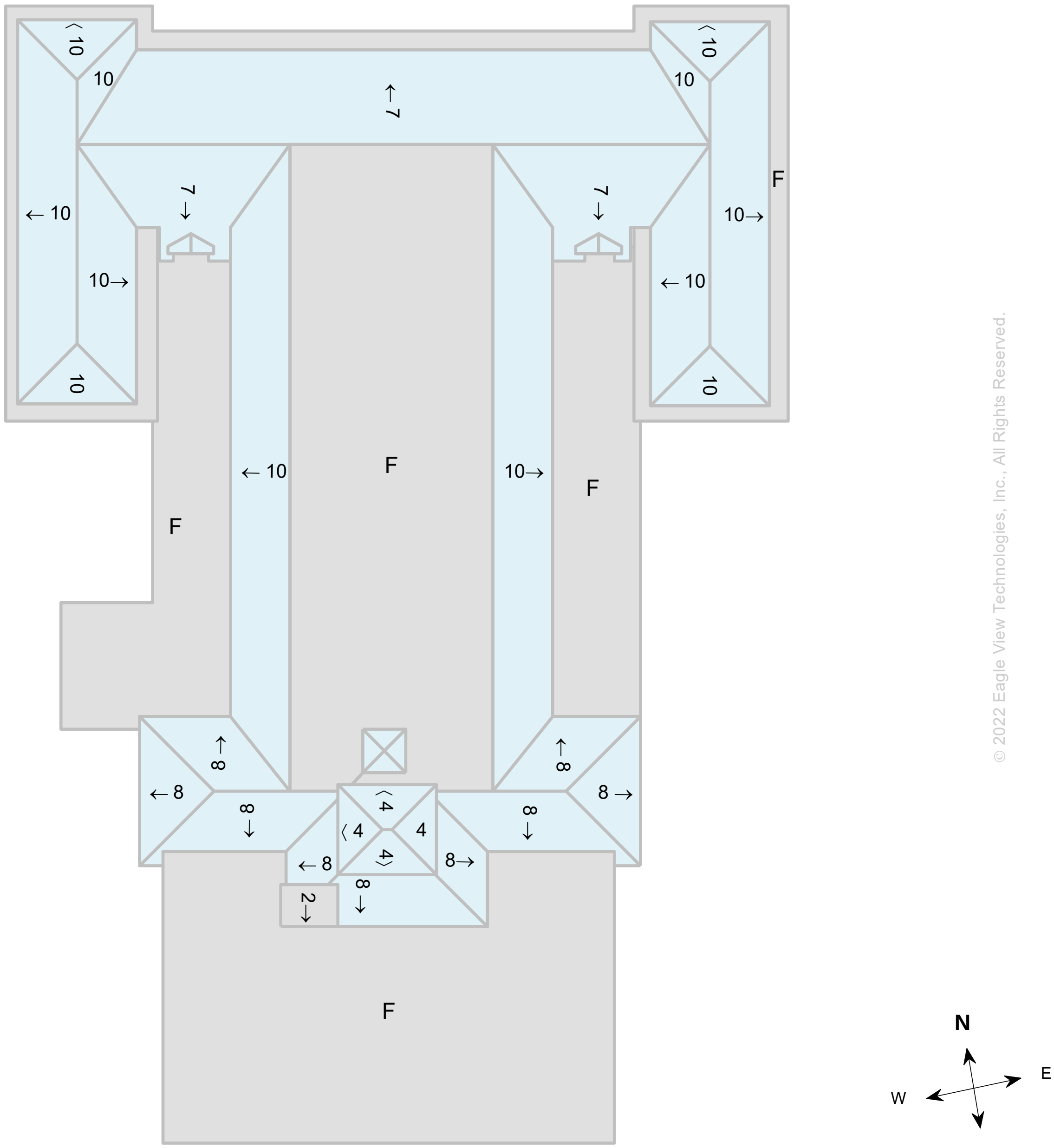
Total Line Lengths:
Ridges = 193 ft
Hips = 295 ft
Valleys = 203 ft
Rakes = 42 ft
Eaves = 1,177 ft
Flashing = 316 ft
Step flashing = 48 ft
Parapets = 0 ft



Note: This diagram contains segment lengths (rounded to the nearest whole number) over 5 feet. In some cases, segment labels have been removed for readability. Plus signs preface some numbers to avoid confusion when rotated (e.g. +6 and +9).

Pitch Diagram

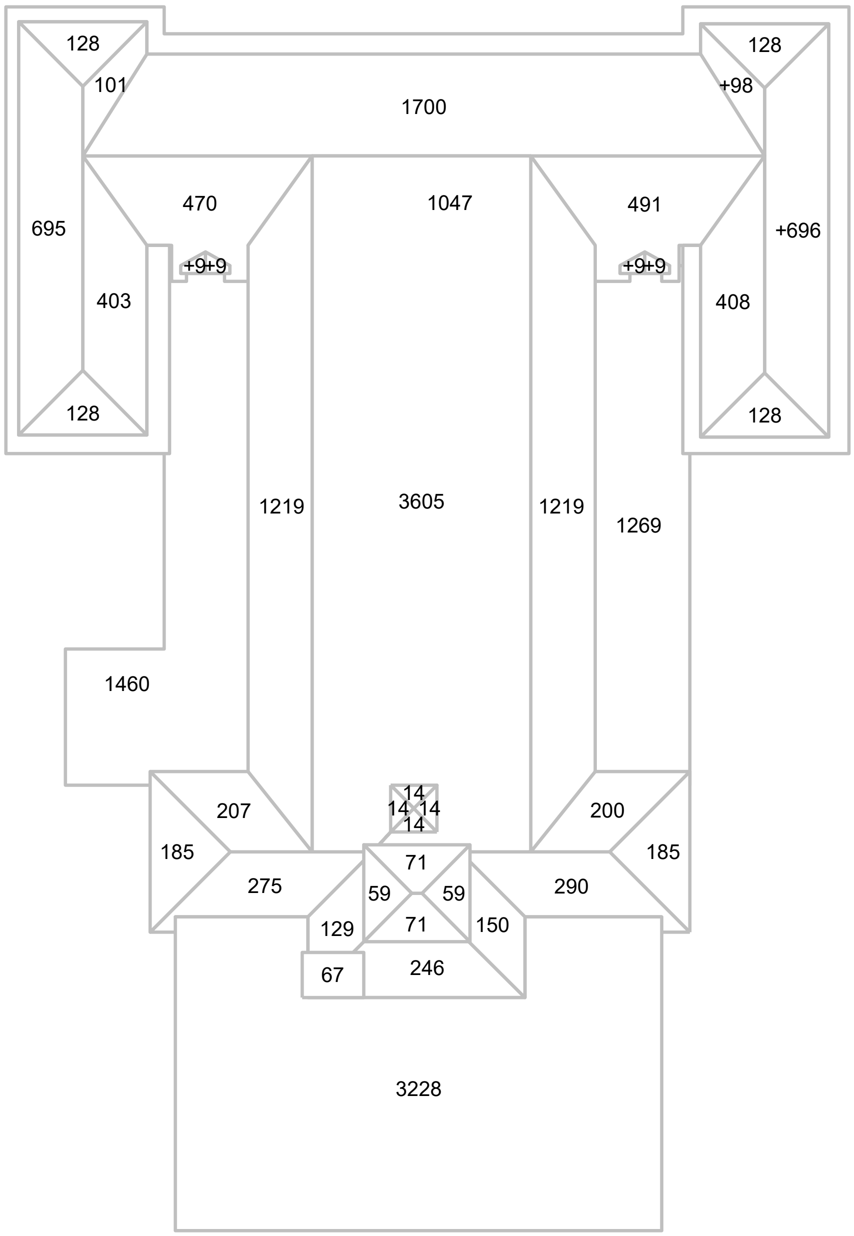
Pitch values are shown in inches per foot, and arrows indicate slope direction. The predominant pitch on this roof is 0/12.



Note: This diagram contains labeled pitches for facet areas larger than 20 square feet. In some cases, pitch labels have been removed for readability. Plus signs preface some numbers to avoid confusion when rotated (e.g. +6 and +9). Blue shading indicates a pitch of 3/12 and greater. Gray shading indicates flat, 1/12 or 2/12 pitches. If present, a value of "F" indicates a flat facet (no pitch).

Area Diagram

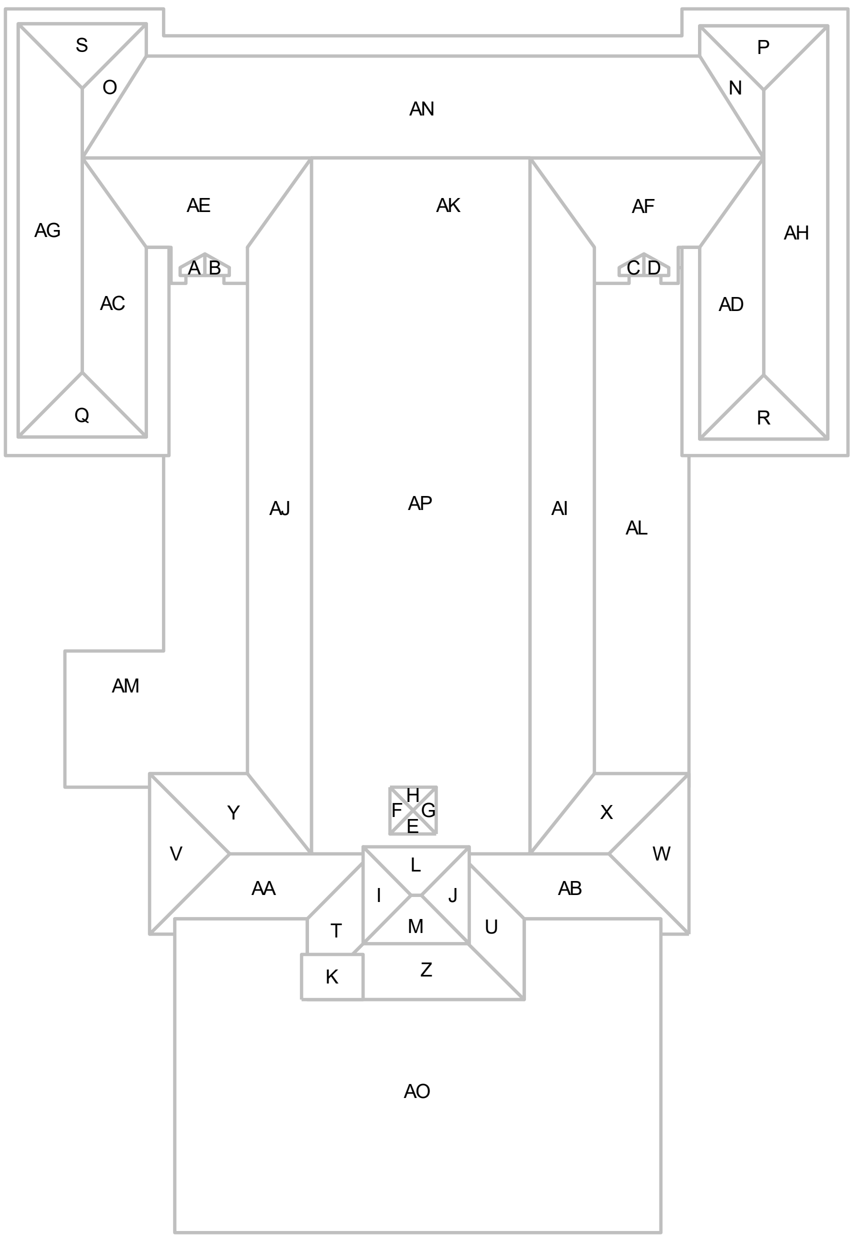
Total Area = 20,909 sq ft, with 42 facets.

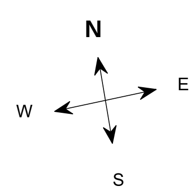


Note: This diagram shows the square feet of each roof facet (rounded to the nearest foot). The total area in square feet, at the top of this page, is based on the non-rounded values of each roof facet (rounded to the nearest square foot after being totaled).

Notes Diagram

Roof facets are labeled from smallest to largest (A to Z) for easy reference.





Penetrations Notes Diagram

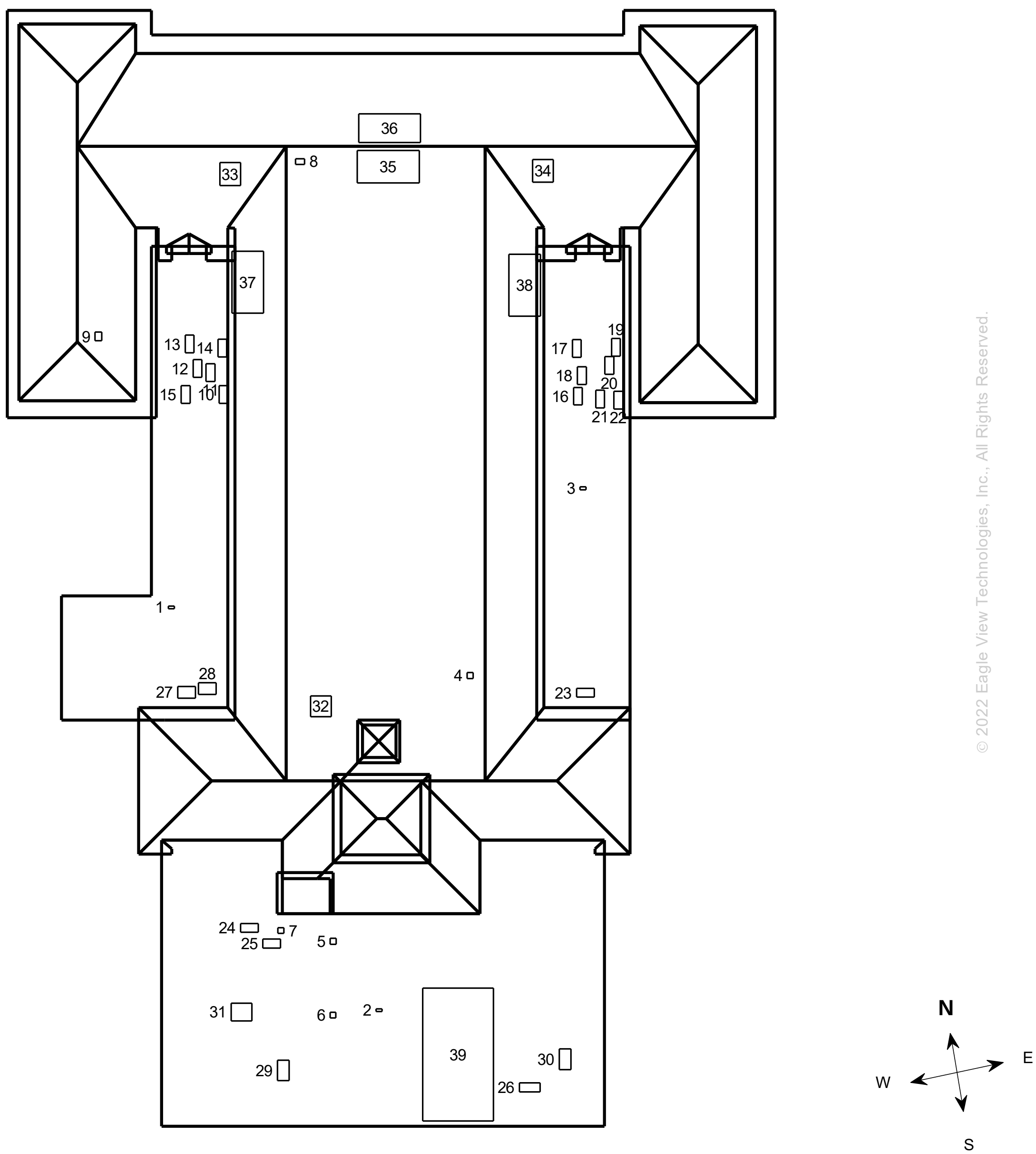
Penetrations are labeled from smallest to largest for easy reference.

Total Penetrations = 39

Total Penetrations Perimeter = 494 ft

Total Penetrations Area = 699 sq ft

Total Roof Area Less Penetrations = 20,210 sq ft



Report Summary

Below is a measurement summary using the values presented in this report.

All Structures

Areas per Pitch						
Roof Pitches	0/12	2/12	4/12	7/12	8/12	10/12
Area (sq ft)	10609.2	67.2	349.6	2661.9	1867.1	5353.6
% of Roof	50.7%	0.3%	1.7%	12.7%	8.9%	25.6%

The table above lists each pitch on this roof and the total area and percent (both rounded) of the roof with that pitch.

Waste Calculation Table

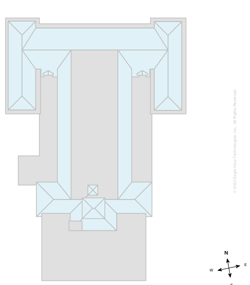
Waste %	0%	10%	12%	15%	17%	20%	22%
Area (sq ft)	20,909	22999.9	23418.1	24045.4	24463.5	25090.8	25509.0
Squares	209.1	230.0	234.2	240.5	244.6	250.9	255.1

This table shows the total roof area and squares (rounded up to the nearest decimal) based upon different waste percentages. The waste factor is subject to the complexity of the roof, individual roofing techniques and your experience. Please consider this when calculating appropriate waste percentages. Note that only roof area is included in these waste calculations. Additional materials needed for ridge, hip, valley, and starter lengths are not included.

Penetrations	1-3	4-7	8	9	10-25	26	27-28	29-30	31	32
Area (sq ft)	0.5	1	1.5	2.2	4.5	5.2	6	7	10.5	12.3
Perimeter (ft)	3	4	5	6	9	10	10	11	13	14
	33-34	35-36	37-38	39						
Area (sq ft)	15.7	57.7	73.5	270						
Perimeter (ft)	16	32	35	69						

Any measured penetration smaller than 3x3 feet may need field verification. Accuracy is not guaranteed. The total penetration area is not subtracted from the total roof area.

All Structures Totals



Total Roof Facets = 42
Total Penetrations = 39

Lengths, Areas and Pitches

Ridges = 193 ft (11 Ridges)
Hips = 295 ft (22 Hips).
Valleys = 203 ft (14 Valleys)
Rakes † = 42 ft (10 Rakes)
Eaves/Starter ‡ = 1,177 ft (46 Eaves)
Drip Edge (Eaves + Rakes) = 1,219 ft (56 Lengths)
Parapet Walls = 0 (0 Lengths).
Flashing = 316 ft (24 Lengths)
Step flashing = 48 ft (10 Lengths)
Total Penetrations Area = 699 sq ft
Total Roof Area Less Penetrations = 20,210 sq ft
Total Penetrations Perimeter = 494 ft
Predominant Pitch = 0/12
Total Area (All Pitches) = 20,909 sq ft

Property Location

Longitude = -71.1564098
Latitude = 42.4157314

Notes

This was ordered as a commercial property. There were no changes to the structure in the past four years.

† Rakes are defined as roof edges that are sloped (not level).
‡ Eaves are defined as roof edges that are not sloped and level.

Online Maps

Online map of property
http://maps.google.com/maps?f=g&source=s_q&hl=en&geocode=&q=730+Massachusetts+Ave,Arlington,MA,02476-4906
Directions from Design Associates, Inc to this property
http://maps.google.com/maps?f=d&source=s_d&saddr=1035+Cambridge+St,Cambridge,MA,02141-1057&daddr=730+Massachusetts+Ave,Arlington,MA,02476-4906

Reference 9

ROBBINS MEMORIAL TOWN HALL AUDITORIUM
730 Massachusetts Avenue, Arlington, Ma. 02476

12 December 2022

To Whom it may concern:

I am writing this letter in support of the proposal to the Community Preservation Committee submitted by to you by Jim Feeney, Deputy Town Manager. The proposal is addressing the leakage issues occurring in the clock tower of Town Hall.

My current role with the Town of Arlington is Event Coordinator for the town. We have successfully been renting Town Hall since 2006. People from all over the greater Boston Area as well as Arlington residents have held important life events in Town Hall – weddings, Bar/Bat Mitzvah's, memorial services, fundraisers, school team banquets, plays, concerts, etc.

The Lyons Hearing Room is an integral part of the rental events – often being used for a cocktail reception before the full dinner and dancing reception of an event. As you would expect, people coming to events at a Town Hall are blown over by the beauty of the entire facility – the auditorium and the Lyons Hearing Room. They are amazed that we have such a gorgeous facility and fascinated by the history of the Robbins family and their involvement in this beautiful structure.

As you now know there is serious concern about the leaking problems that we are experiencing from the clock tower. Over the last few weeks more active leaking is occurring in the ceiling of the Lyons Hearing Room. We are now required to put buckets on the conference tables to catch the water and the leak is spreading across the ceiling. Bits of plaster are beginning to fall from the ceiling. In the past there were times when water was literally coming through the light structure in the ceiling!

We are in jeopardy of doing serious damage to this ceiling in the Lyons Hearing Room in addition to the damage that the offices have incurred.

It's so important that we preserve this beautiful structure that the Robbins family has given us and so important to continue offering its use to Arlington people and others for their important life events.

I'm so hoping that you will be able to fund this proposal.

Sincerely,

Patsy Kraemer
Events Coordinator
Town of Arlington

Reference 9

From: Richard Duffy <richard@arlingtonhistorical.org>
To: jfeeney@town.arlington.ma.us
Date: 12/14/2022 09:45 AM
Subject: Letter of Support / CPA Application / Town Hall Clock Tower

December 14, 2022

To the Community Preservation Act Committee:

I am writing in support of the CPA grant application for funds to comprehensively repair and restore the Robbins Memorial Town Hall's clock tower (sometimes referred to as its "cupola" or "lantern").

Over recent decades piecemeal repairs have not held. There have been responses when water infiltration has been obvious in the Lyons Hearing Room immediately below the tower; however, small water leaks are insidious and are often responsible for greater damage. After 109 years, the time is overdue to fully rectify the situation.

It is especially important to protect the Lyons Hearing Room from damage because, unlike plaster walls in most other sections of the building, its American Chestnut paneling is irreplaceable. This is not only because of the patina of age it possesses; the American Chestnut tree virtually disappeared due to catastrophic blight. Having to replace even sections of the paneling with reclaimed materials would compromise the visual and historical integrity of the space.

Through the generosity of the Robbins Family, Arlington's town hall was designed by one of America's most prominent architects, R. Clipston Sturgis. His overall design concept extended to execution of exceptional interior details and materials, such as the use of chestnut in the hearing room and auditorium, and especially the high-end elements of the Arts and Crafts Movement as seen in the decorative plasterwork, and especially in the four museum-quality iron gates by renowned artisan Frederick Krasser.

Thank you for considering this essential reinvestment in a building that is both an active municipal and community space, and an undeniable historical and cultural icon of Arlington.

Very truly yours,

Richard A. Duffy

OFFICE OF THE SELECT BOARD

LENARD T. DIGGINS, CHAIR
DIANE M. MAHON, VICE CHAIR
JOHN V. HURD
STEPHEN W. DECOURCEY
ERIC D. HELMUTH

730 MASSACHUSETTS AVENUE
TELEPHONE
781-316-3020
781-316-3029 FAX

TOWN OF ARLINGTON
MASSACHUSETTS 02476-4908

MEMORANDUM

TO: James Feeney, Deputy Town Manager

FROM: Office of the Select Board

DATE: December 13, 2022

RE: Town Hall Restoration Letter of Support

The significance of Town Hall should merit restoration on its own terms. However, the magnitude of the dilapidation makes restoration much more vital. The Select Board Chambers and office face the burden of the neglect. The water damage from the roof produces rotting ceilings in the chambers and deteriorates into the area of the audience. The office's antiquated windows are too drafty in the winter and not enough in the summer the exact opposite preference. The dysfunctional heating system, New England winters, and drafty windows create a frigid work environment. The windows not only house broken screens and cracking sills but also two hornets' nests and a way in for flies. The weights in the window's interior have since broken and have been replaced by a book. Restoring the exterior of Town Hall is crucial to preventing further ruin.

After losing Arlington's first Town Hall (originally located at the intersection of Massachusetts Avenue and Mystic Street), the responsibility to repair this structure cannot be ignored. Restoration is not only recommended but a prerequisite, as the Chair of the Select Board, Frank V. Noyes, said on its inauguration in 1913:

> "We hope that the [Town Hall] will in every way answer the various purposes for which it is intended, and that our townspeople will take a just pride in its care and maintenance."

OFFICE OF THE TOWN CLERK

TOWN OF ARLINGTON
730 MASSACHUSETTS AVENUE
ARLINGTON, MA 02476

TELEPHONE: 781-316-3070
TownClerk@town.arlington.ma.us

JULIANA H. BRAZILE
TOWN CLERK

December 8, 2022

Jim Feeney
Office of the Town Manager
730 Massachusetts Avenue
Arlington, MA 02476

Re: Condition of Town Clerk's Office Space and the Lyons Hearing Room

I am writing on behalf of myself and my staff to support your efforts to secure funding for repairs to Town Hall. The leaks in the Lyons Hearing Room create significant concerns around elections since that is the space we use for processing ballots that are being mailed. It is awkward to ask volunteers not to work at one end of the room if they are handling ballots because water is dripping steadily from the ceiling. The thought that a new leak could damage ballots that have been stored in a section of the room that previously stayed dry keeps me up at night during a bad storm.

In addition, I would hope that attention can be paid to the windows in the Lyons Hearing Room and my office. Working storm windows would make conditions more pleasant and the spaces more energy efficient. I have seen election volunteers and Town staff working in the Lyons Room in coats because of the drafts.

In my suite, we have storm windows that are stuck partially open and can't be moved. We see water damage in some sections of our ceiling and have a constant rain of paint and plaster powder on working spaces. A couple of months ago large pieces of ceiling fell in the hallway outside our office raising staff concerns about the risk of head injuries.

We applaud your efforts to address these issues and eagerly await results.

Sincerely,

Juliana H Brazile

Juliana H. Brazile
Arlington Town Clerk

Office of the Treasurer & Collector of Taxes
Town of Arlington, Massachusetts

730 Massachusetts Avenue
Arlington, MA 02476

Telephone Number: 781-316-3031
Facsimile Telephone: 781-316-3089

Phyllis L. Marshall
Treasurer & Collector of Taxes

December 9, 2022

Clarissa Rowe, Chair
Community Preservation Act Committee
730 Massachusetts Ave.
Arlington, MA 02476

RE: Project for Exterior Improvements to the Arlington Town Hall

Dear Chair Rowe:

I respectfully request favorable consideration by the Community Preservation Act Committee for funding of the project submitted for exterior improvements to the Town Hall.

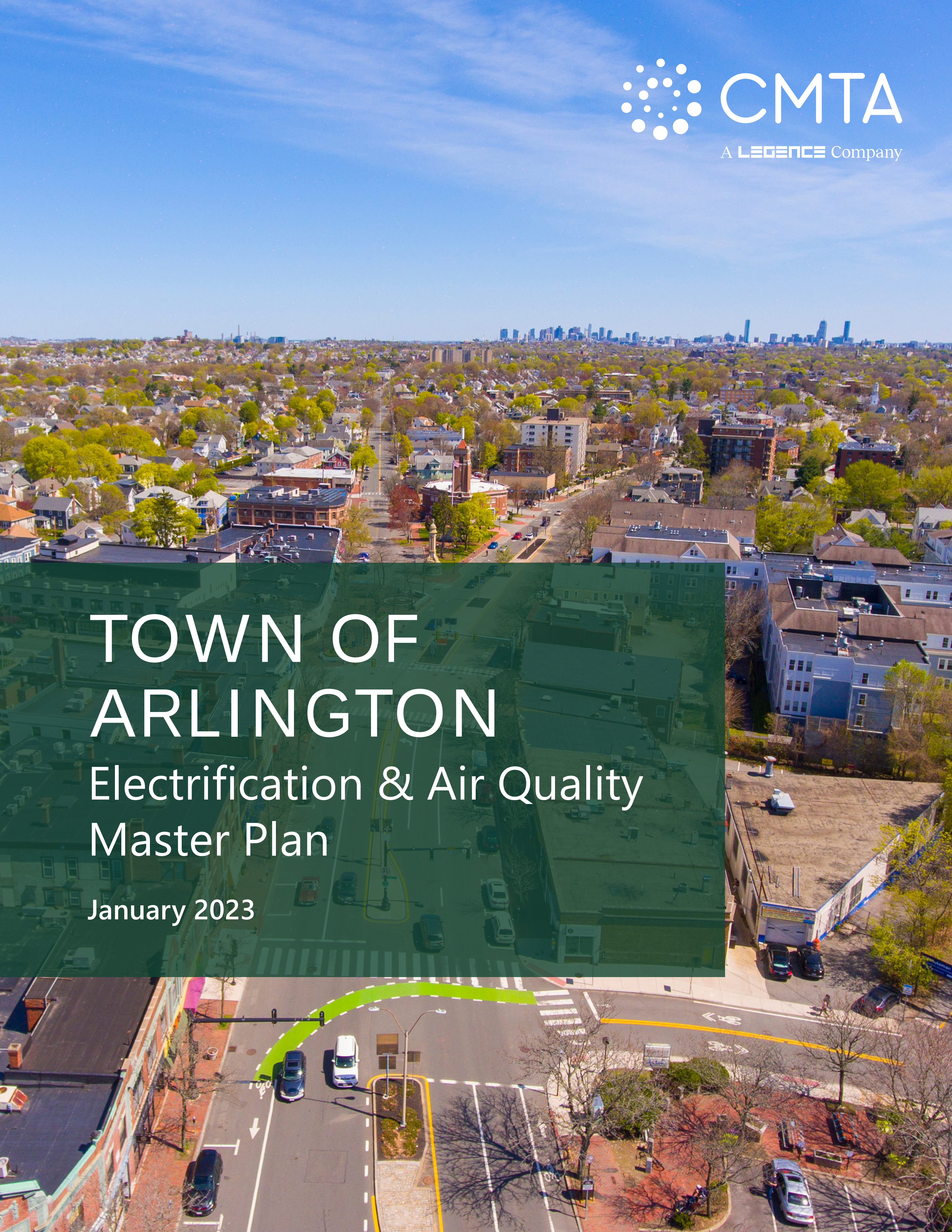
Many of the windows for the offices of the Treasurer – Collector office are not functioning and paint on the exterior is peeling away from them.

We have received comments from the public regarding the condition of the exterior drop box location imbedded into the front of the Town Hall and the fact that the wood frame is exposed due to paint peeling.

In addition, the front doors are difficult to operate and remain open during hours when the Town Offices are open. During the months when this occurs, it makes the public areas of the building hotter or colder than the offices and humidity makes the public doors to offices difficult to open and close.

Thank you,

Phyllis L. Marshall
Treasurer – Collector



CMTA

A LEGENCE Company

TOWN OF ARLINGTON

Electrification & Air Quality Master Plan

January 2023

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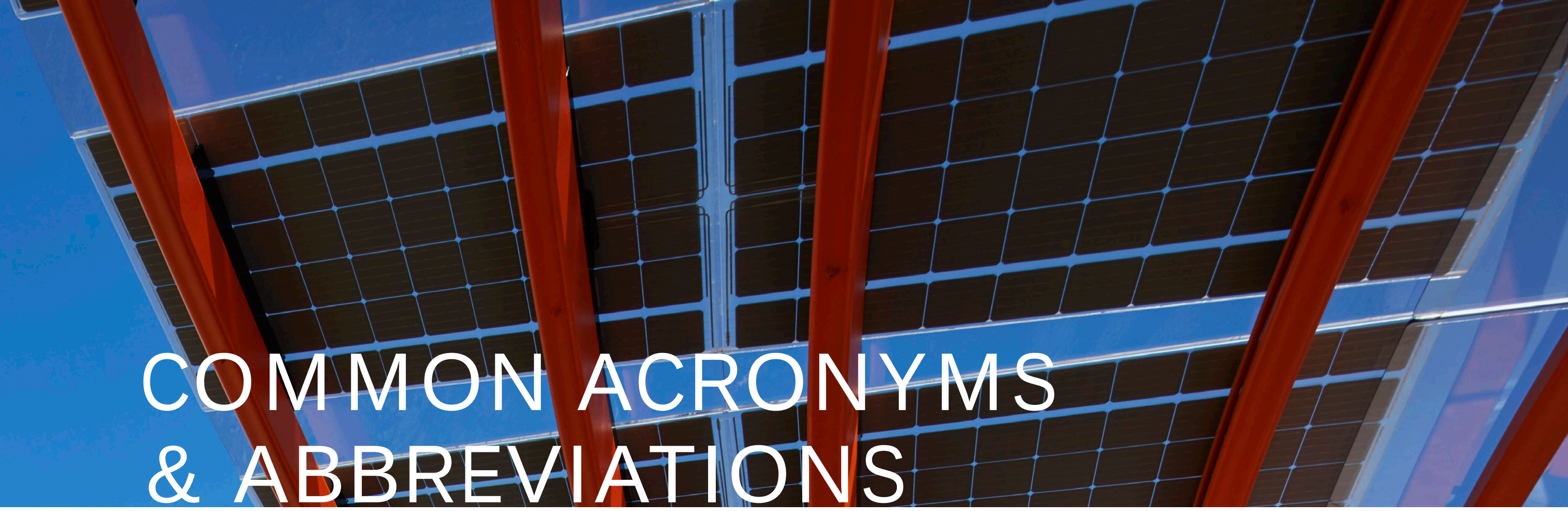


COMMON ACRONYMS & ABBREVIATIONS

AHU: Air Handling Unit

APS: Arlington Public Schools

ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

BAS: Building Automation System

BERDO: Boston Emissions Reduction Disclosure Ordinance

CMTA: Consulting engineering firm, hired for this study

Cx: Commissioning

DOAS: Dedicated Outdoor Air System

Dx: Direct Expansion Cooling

EPA: Environmental Protection Agency

EUI: Energy Use Intensity, building efficiency measured in thousands of British Thermal Units per square foot per year (kBtu/SF/yr)

GHG: Greenhouse Gases

GHI: Global Horizontal Irradiance

HVAC: Heating, Ventilation, and Air Conditioning

IRA: Inflation Reduction Act

ISO-NE: Independent System Operator New England, the New England electric grid

ITC: Investment Tax Credit

kBTU: Kilo British Thermal Units, unit for energy

kWh: Kilowatt Hour, unit of energy

LCCA: Life Cycle Cost Analysis

LED: Light Emitting Diode

MSBA: Massachusetts School Building Authority

MTCDE: Metric Tons of Carbon Dioxide Equivalent

NREL: National Renewable Energy Laboratory

NZAP: Net Zero Action Plan, a publication by the Town of Arlington released in February of 2021

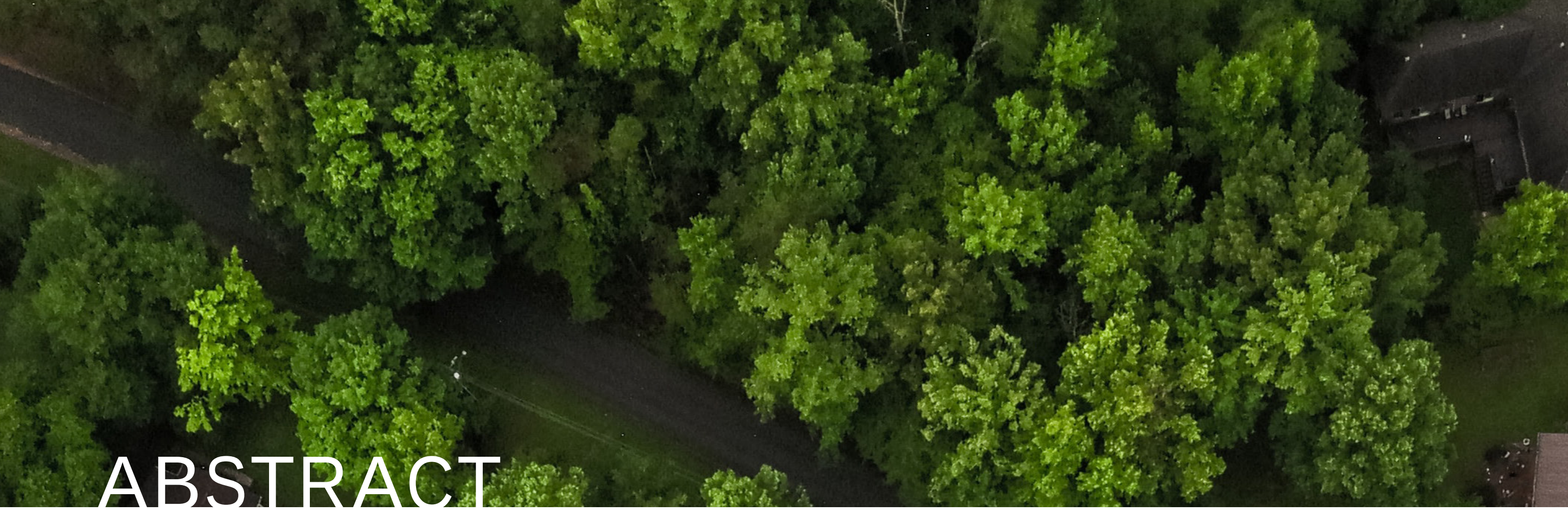
PV: Photovoltaic

RTU: Rooftop Unit

VRF: Variable Refrigerant Flow

EXECUTIVE SUMMARY

ABSTRACT
GOALS & OBJECTIVES
SUMMARY OF FINDINGS
THIRTY YEAR LIFE CYCLE COSTS
STRATEGIC ROADMAP
FUNDING FLOWS



ABSTRACT

The rate of change of carbon dioxide levels in the atmosphere is unparalleled. The US Energy Information Administration estimates 5.1 billion metric tons of energy related carbon were emitted in 2019 in the United States. Buildings are responsible for 40% of this energy consumption. Proactive efforts to improve new and existing building stock, like the Town of Arlington's 2021 Net Zero Action Plan (NZAP), released in February of 2021, will play a huge role to mitigate climate change. The Town of Arlington has pledged to reduce greenhouse gas (GHG) emissions to net zero emissions by 2050. The Town's NZAP recommends that all Town buildings be made fully electric, and that all municipal electricity be supplied from renewable sources.

Electrifying will achieve a reduction in local combustion and thus GHG emissions at the Town level. Importantly, a reduction in combustion improves air quality, which has community health benefits. The negative impacts of poor outdoor air quality include heart attacks, asthma attacks, bronchitis, hospital and emergency room visits, work and school days lost, restricted activity days, respiratory symptoms, and premature mortality.

Arlington Public Schools (APS) understands the link between air quality and wellness, and has committed to providing healthy and productive learning and working environments for all students, faculty, staff and visitors. The Town's building electrification goal will support improved indoor air quality by reducing exposure to on-site fossil fuel burning and/or energy consumption. In addition, APS's goal of improving air quality and ventilation, while ensuring comfortable temperatures, will improve learning and working environments while also minimizing the spread of COVID-19 and other airborne illnesses.

The Town of Arlington commissioned CMTA, Inc. to prepare a comprehensive Electrification and Air Quality Master Plan focusing on engineering and economic analyses of current and proposed heating, cooling, ventilation, and air filtration systems for Bishop Elementary, Brackett Elementary, Hardy Elementary, Peirce Elementary, Dallin Elementary, and Ottoson Middle School. Studying these six schools was in direct response to the NZAP and health concerns raised by the COVID-19 pandemic. This Master Plan provides a comprehensive roadmap that will help the Town chart a course to achieve ambitious targets at the six school buildings.

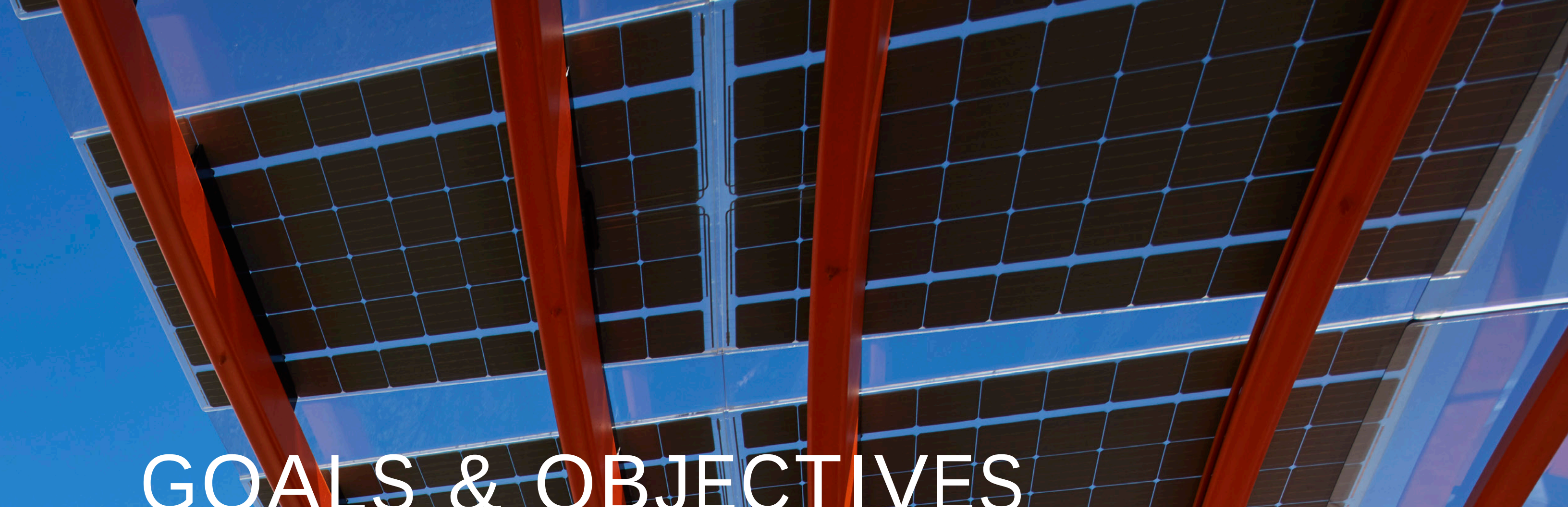
The Master Plan is broken down into three phases:

Phase I – Building System Inventory and Assessment

Phase II – Alternative Electrification and Air Quality Improvement Options

Phase III – Investment Plan

The authors commend these actions towards adopting more sustainable facilities. We would like to extend a special thanks for the support from Town personnel Jim Feeney, Talia Fox, Robert Behrent, Fergal O'Brien, and Ken Pruitt for their assistance during the preparation of this Master Planning Document.



GOALS & OBJECTIVES

The purpose of this Master Plan is to develop a path forward for six schools in the Town of Arlington to achieve net zero GHG emissions by the year 2050. The Town's NZAP recommends the electrification of all Town buildings, but this study focuses on these six schools because they have not been recently renovated. Therefore, electrification could occur within the cycle of regularly scheduled capital upgrades. In addition to electrification, achieving the Town's goals will require capital investments to achieve drastic reductions in both energy demand and consumption. The study also addresses occupant satisfaction and wellness, focusing on heating, cooling, ventilation, and air filtration system concerns raised by the COVID-19 pandemic.

Key over-arching goals and objectives for this Master Plan include:

1. Develop timelines and cost estimates to eliminate fossil fuel consumption and electrify and improve indoor air quality at six school buildings per the Town's 2021 (NZAP). This involves heating, ventilating, and air conditioning (HVAC) systems, domestic water heating, and kitchen/foodservice functions.
2. Establish options, feasibility, and priorities for drastic energy reductions and electrification at each site while adding air conditioning and mechanical ventilation throughout. Discussions with the Town narrowed the options for all electric HVAC systems to either a variable refrigerant flow system or a ground source heat pump system. These choices do not reflect all options for electrified systems, but offer the study of an air-cooled system type and a water-cooled system type. Hybrid options exist but were not studied.
3. Provide a practical evaluation of on-site photovoltaics that enables the Town to take the next steps for budgeting and planning purposes. Attaining on-site net zero energy is not required.

For the Town to reach its stated goal of carbon neutrality by 2050, there are several programs of investment to consider for direct and indirect carbon emission reductions, including:

1. Investment in physical infrastructure, deferred maintenance, and efficiency improvements that leverage utility incentives, where applicable. An emphasis on increasing overall efficiency and thoughtful system design is critical in making electrification financially viable.
2. Investment in on-site renewable energy sources to lower energy costs and reduce emissions associated with electricity production (while the electric grid still uses some fossil fuels), where feasible.
3. Purchase of renewable energy credits to offset any remaining electricity-related emissions.
4. Leverage the tax provisions of the Inflation Reduction Act of 2022 allowing state and local governments to receive "direct pay" tax credit reimbursements for ground source heat pump and solar photovoltaic (PV) systems.

SUMMARY OF FINDINGS

The intent of the study was to identify options for the Town to electrify five elementary schools and Ottoson Middle School. This includes evaluating electrification and renewable energy options, providing cost data, and suggesting the order in which improvements at each school should be implemented. Throughout the process, CMTA and the Town have agreed that the key to electrification is to focus on energy efficiency and energy reduction first. Following efficiency improvements, systems can be electrified and remaining GHG emissions can be offset through the purchase of offsets or installation of clean energy generating systems because the Town has limited real estate to install solar PV systems. After careful evaluations of PV ownership, the Town noted that procuring offsets may be more viable following electrification of all buildings and before the grid becomes 100% clean. The Town aims to achieve net zero emissions but does not seek to achieve net zero energy. Specific energy conservation measures are recommended in the Phase II section of this report.

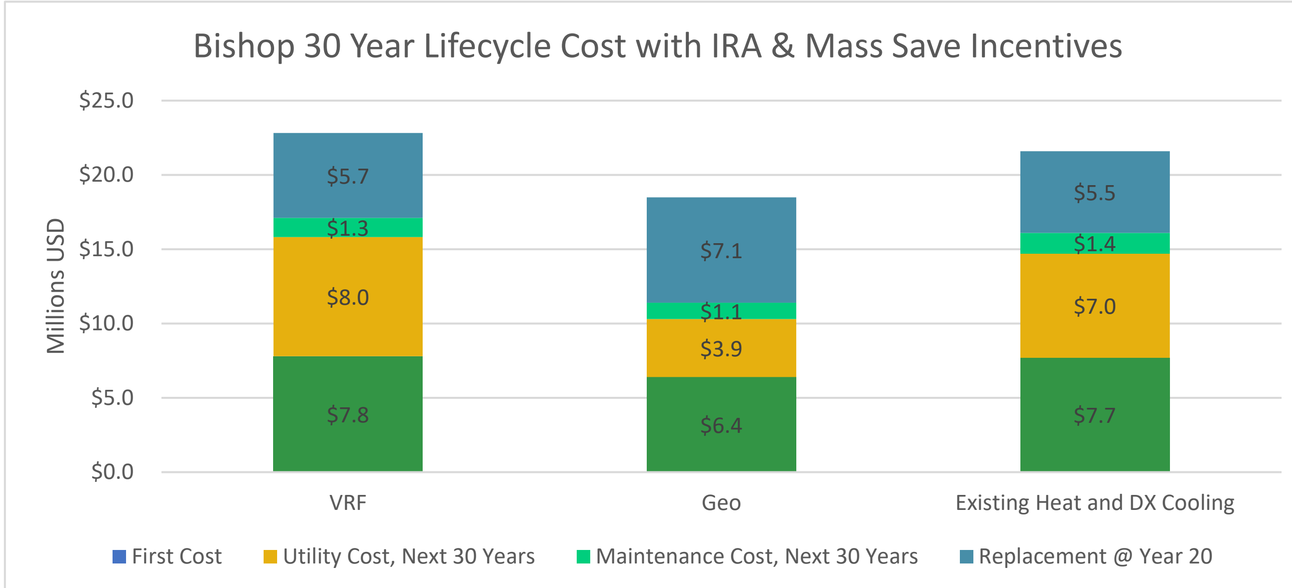
This Master Plan evaluated two options: a variable refrigerant flow system and a ground source heat pump system. These two systems were selected to represent an air source and water source option. Although hybrid options exists, other systems were not evaluated based on limitations in scope. For each of the systems, a conceptional design was completed. The narrative and zoning diagrams associated with each system are available in Appendices A and B. Equipment cut sheets were solicited from vendors and are available in Appendix C. These informed a cost estimation exercise. The results are available in Appendix D.

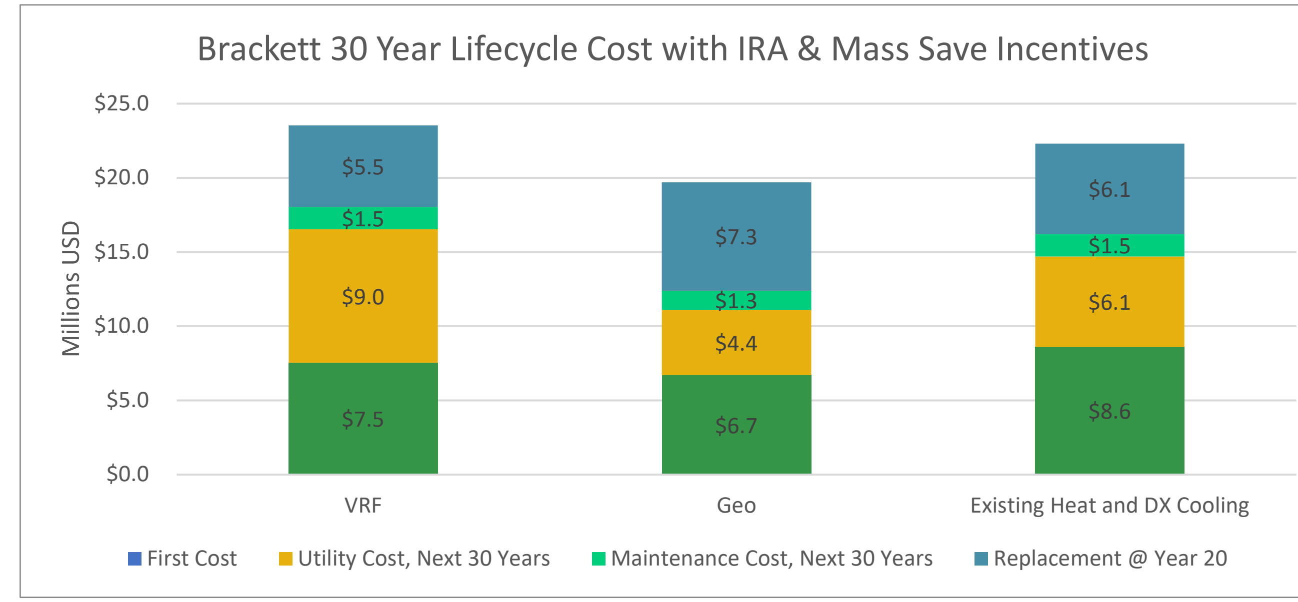
System selection is not within the scope of this Master Plan. The analysis in the Phase III section of this report is meant to provide the Town with data to make an informed decision. Three cases were analyzed: a variable refrigerant flow (VRF) option, a ground source heat pump option, and a business as usual option. The business as usual case maintains existing gas heat and adds air conditioning via direct expansion (DX) cooling. This offers a point of comparison for the minimum cash flows that would be required to upkeep existing systems and add mechanical cooling to the schools.

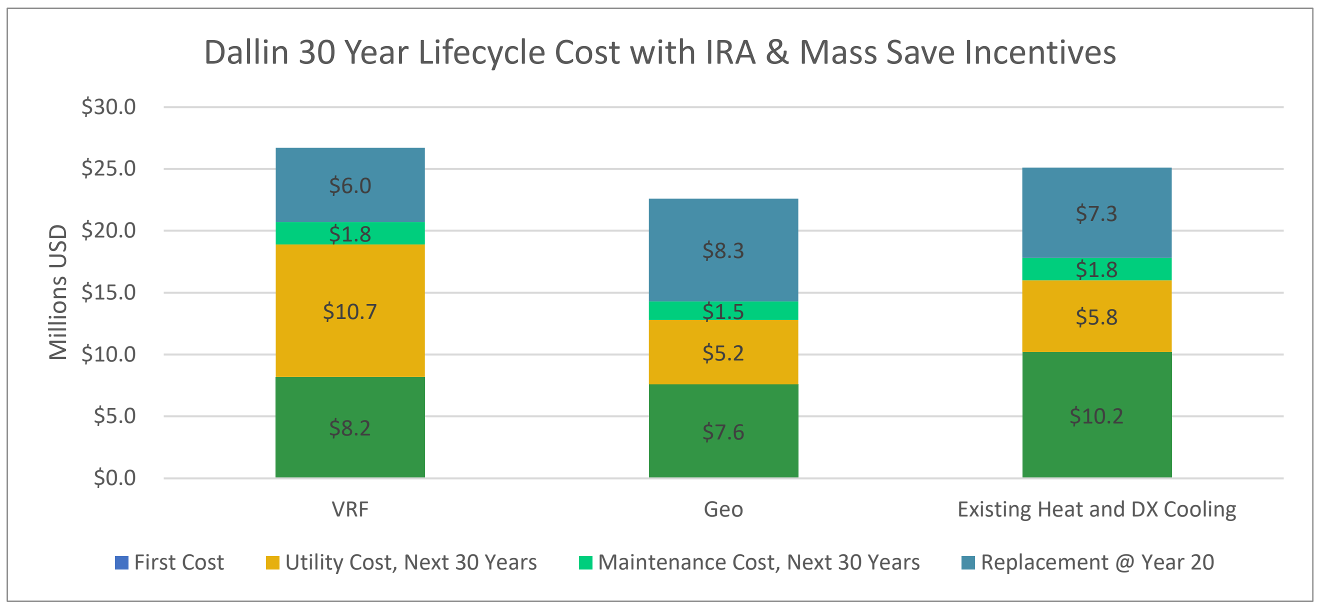
CMTA recommends selecting a system based on life cycle cost, rather than first cost. A 30 year life cycle cost analysis (LCCA) was performed and includes: intial project costs to design and install an all-electric system, utility costs, maintenance costs, and 20-year partial replacement costs. The LCCA also includes the estimated incentives from the Inflation Reduction Act and the MassSave incentive program run by New England utilities. See the stacked bar charts reflecting these costs for each of the schools on the following page. Details on methodology and assumptions are available in the Phase III portion of this report. The trends show that ground source heat pump systems are more expensive than VRF when comparing first cost, but more affordable over the system lifespan, even moreso when incentives are considered. For instance, the geothermal IRA incentives for Ottoson and Bishop almost cover the cost to upgrade Brackett. See the stacked bar charts reflecting these costs for each of the schools on the following page.

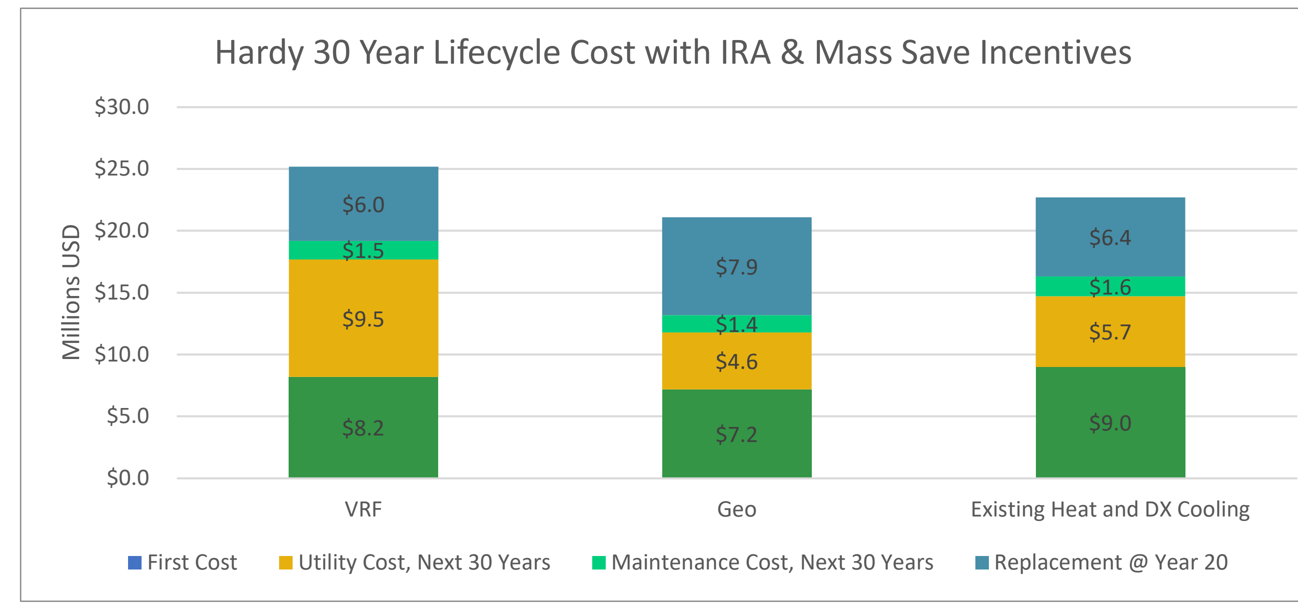
Using the information gathered in Phases I and II, the CMTA team developed a framework to establish a recommended order for school renovation, shown in the Strategic Roadmap on page nine. This study recommends that Ottoson Middle School seek Massachusetts School Building Authority (MSBA) funds for a more comprehensive building renovation before funds are invested in an HVAC electrification retrofit.

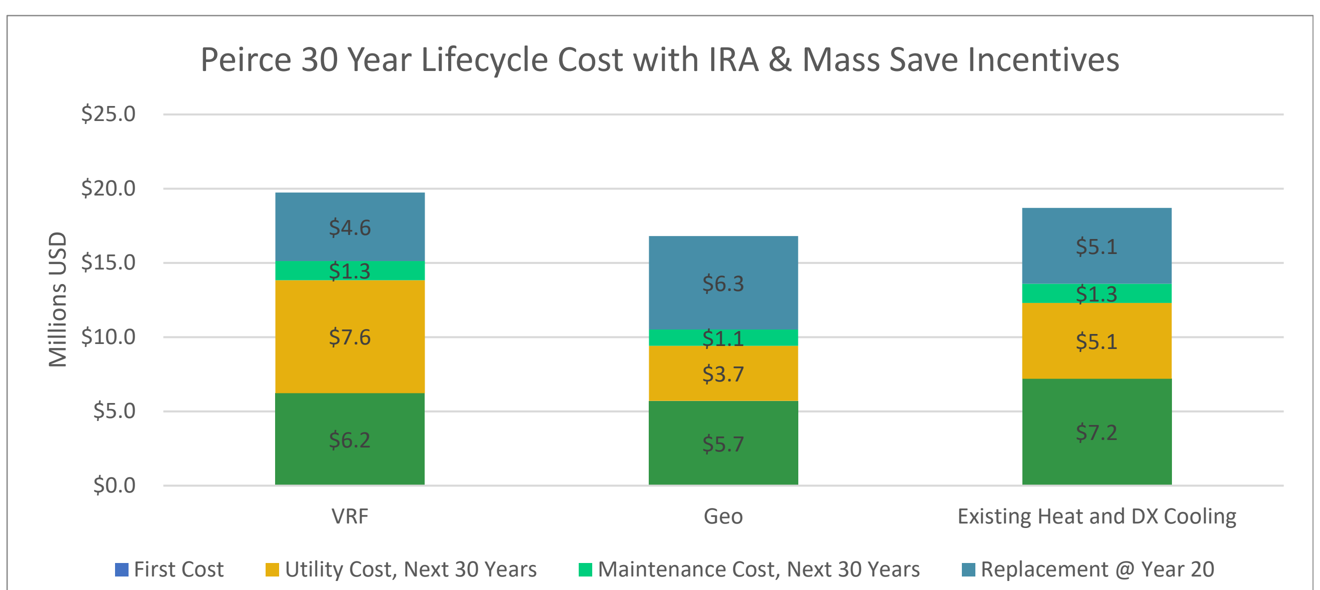
30-YEAR LIFE CYCLE COST WITH IRA & MASS SAVE

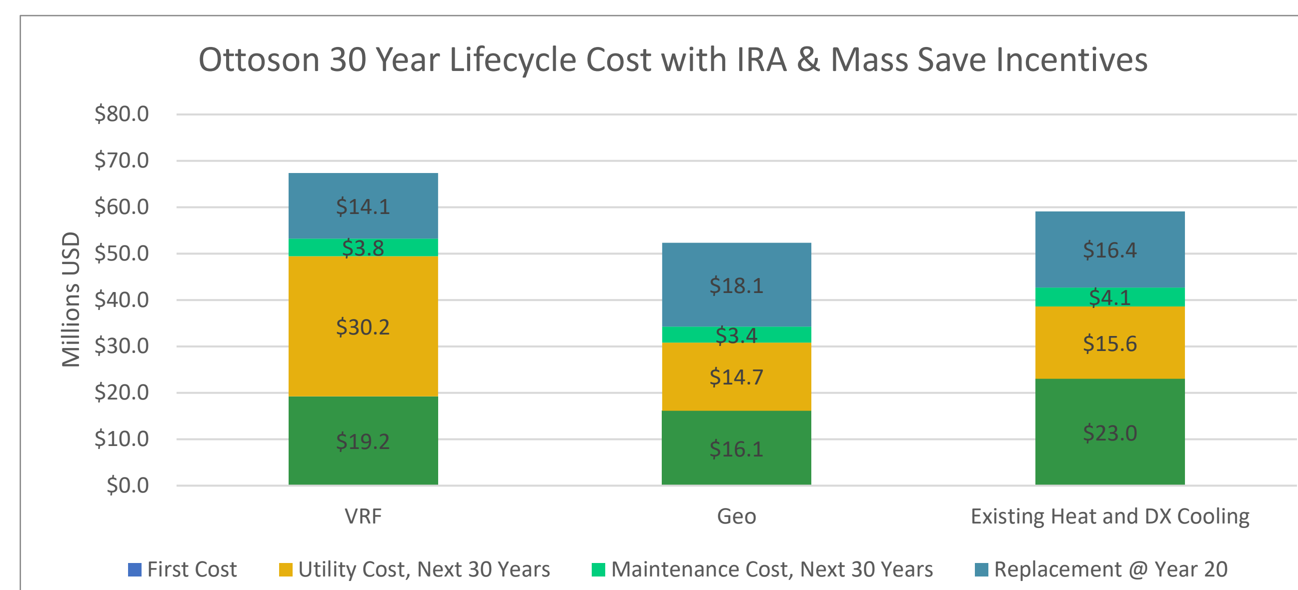




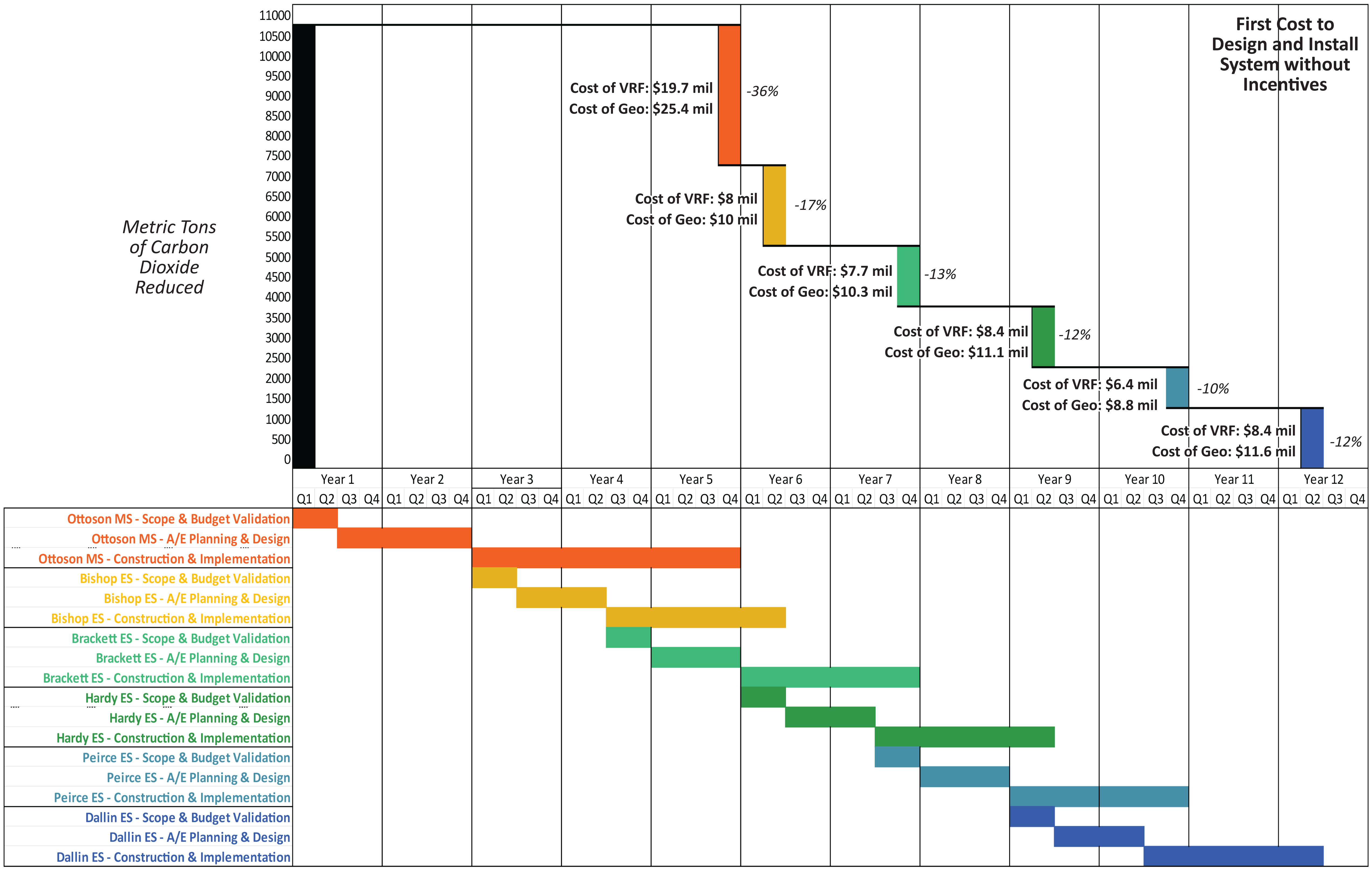








STRATEGIC ROADMAP



The analysis presented optimized the ranking and sequencing of projects based on order of magnitude of cost, emissions reduction potential, and need for infrastructure renewal. These recommendations are detailed in the Phase III section of this report. While the established goal of electrification by 2050 may seem far in the future, when considering the project scope to retrofit six schools, factoring in the design and construction period, as well as the planning for funding outlays of this magnitude in advance, the Town ishould initiate this process early. The chart above is the culmination of all three phases. It shows the recommended project phasing, the impact project completion would have on site emissions in the Town of Arlington, and the first cost for each viable, fully electrified option.

FUNDING FLOWS

	Variable Refrigerant Flow		Ground Source Heat Pump	
	Spend	**Rebate/Incentive**	**Spend**	**Rebate/Incentive**
Year 1				
Ottoson MS	$ (19,700,000.00)		$ (25,400,000.00)	
Year 2				
Year 3				
Bishop ES	$ (8,000,000.00)		$ (10,000,000.00)	
Year 4				
Brackett ES	$ (7,700,000.00)		$ (10,300,000.00)	
Year 5				
Year 6				
Hardy ES	$ (8,400,000.00)		$ (11,100,000.00)	
Ottoson MS Mass Save Incentive		$ 438,000.00		$ 1,655,000.00
Ottoson MS IRA Incentive		$ -		$ 7,600,000.00
Year 7				
Peirce ES	$ (6,400,000.00)		$ (8,800,000.00)	
Bishop ES Mass Save Incentive		$ 169,000.00		$ 599,000.00
Bishop ES IRA Incentive		$ -		$ 3,000,000.00
Year 8				
Brackett ES Mass Save Incentive		$ 151,000.00		$ 548,000.00
Brackett ES IRA Incentive		$ -		$ 3,100,000.00
Year 9				
Dallin ES	$ (8,400,000.00)		$ (11,600,000.00)	
Year 10				
Hardy ES Mass Save Incentive		$ 195,000.00		$ 586,000.00
Hardy ES IRA Incentive		$ -		$ 3,300,000.00
Year 11				
Peirce ES Mass Save Incentive		$ 159,000.00		$ 459,000.00
Peirce ES IRA Incentive		$ -		$ 2,600,000.00
Year 12				
Dallin ES Mass Save Incentive		$ 189,000.00		$ 529,000.00
Dallin ES IRA Incentive		$ -		$ 3,500,000.00
Totals	$ (58,600,000)	$ 1,301,000	$ (77,200,000)	$ 27,476,000
Net Spend	**$**	**(57,299,000)**	**$**	**(49,724,000)**

The table above demonstrates the first cost allocations and expected incentives for each system. First cost represents the cost for either system in year one of a project. For any incentives, disbursment is typically allocated one year after the project is completed. The delay reflects the estimated time required to conduct a cost segregation study.

PHASE I
BUILDING SYSTEM INVENTORY & ASSESSMENT

PHASE I OBJECTIVES

The CMTA team spent time at each of the six school facilities to gain a general understanding of the existing conditions of the buildings. We visually spot checked the major systems and recorded details of each building to understand the installation and operations including the HVAC systems, building management systems, air filtration, main electrical services, and domestic water heating systems.

During the site visits, CMTA performed a high-level review of the building envelope (roofs, walls, windows) and reviewed potential implementation strategies for new HVAC systems as defined in Phase II. Additionally, the carbon emissions, energy use intensity, and cost intensity of each of the sites were benchmarked using annual utility data provided by the Town.

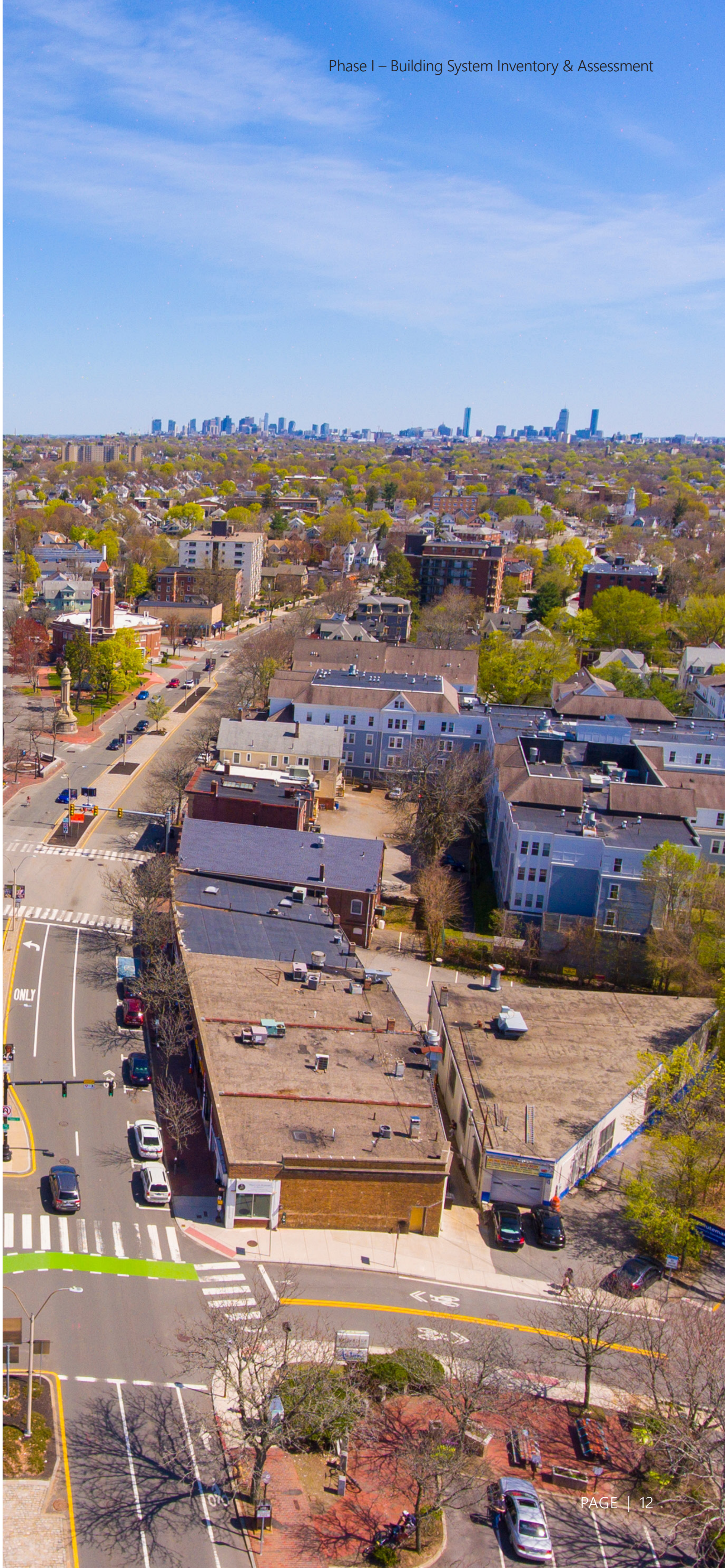
The scope of Phase I did not include the following items:

a. Detailed and comprehensive inventory of HVAC equipment including makes, model numbers, capacities, distribution and zoning, filtration, control sequences, warranties, life expectancies, maintenance histories, etc.
b. Detailed and comprehensive inventory of electrical equipment including number and locations of panelboards, transformers, circuit breakers (used and unused), warranties, life expectancies, maintenance histories, etc. Additionally, electrical metering was not performed.
c. Computerized energy modeling, building management trend reviews or test and balance surveys.

About the Town of Arlington

The Town of Arlington is a suburban community located in Middlesex County, approximately six miles northwest of Boston. Arlington covers 3,518 acres, or 5.5 square miles. Arlington's population is 46,844 (2020 US Census). A total of 5,755 students are served by the district across 11 public school buildings: the six schools that are the subject of this Master Plan as well as Arlington High School, the Gibbs Middle School, Menotomy Preschool, and the Thompson and Stratton elementary schools.

The Town has a history of setting and achieving sustainability goals starting with its first climate action plan, the Arlington Sustainability Action Plan (ASAP), adopted in 2005. The ASAP called for a 10% reduction in greenhouse gas (GHG) pollution by 2010, and 20% by 2020, and the Town achieved both. Arlington is a state-designated Green Community. Beginning in 2018, it became a member of the Metropolitan Mayors Coalition, which commits the Town to achieving net zero GHGs by 2050. The Town is currently in the process of enacting the necessary steps to meet the goals of the 2021 Net Zero Action Plan.



About the Schools

The general physical conditions of the five elementary schools were good, while conditions at Ottoson Middle School were fair. Across the six schools, windows were generally observed to be double-paned and operable. There were a few instances of blown seals and many instances where the windows were observed open. Most site visits occurred in early 2022 on days where the temperatures ranged from 15-35 °F. The open windows suggested there are some thermal comfort issues but could also be a remnant of COVID-19 precautions.

In all schools, air gaps were observed around exterior doors, leading to unnecessary air infiltration. Examples appear in ***Figures 1 and 2*** on the right.

All roofs were observed visually in good condition for their ages, which ranges from 17-24 years old.

The mechanical systems are well maintained but aged and past useful life. All schools currently have gas-fired boilers and no school has complete central air conditioning. There are a few individually air-conditioned offices and classrooms across the six schools.

The electrical infrastructure is also in good condition. With well-designed HVAC systems, the service size should be able to support the proposed electrification in all but two schools: Bishop and Hardy Elementary.

All schools have partially upgraded lighting. All external lights and a portion of internal lights have been converted to LEDs.

Equipment in the kitchens is not completely utilized as the food is now centrally prepared at Thompson Elementary School. Accordingly, the kitchens at each of the six schools studied are used primarily for warming rather than preparing food, which enhances kitchen efficiency and overall school efficiency.

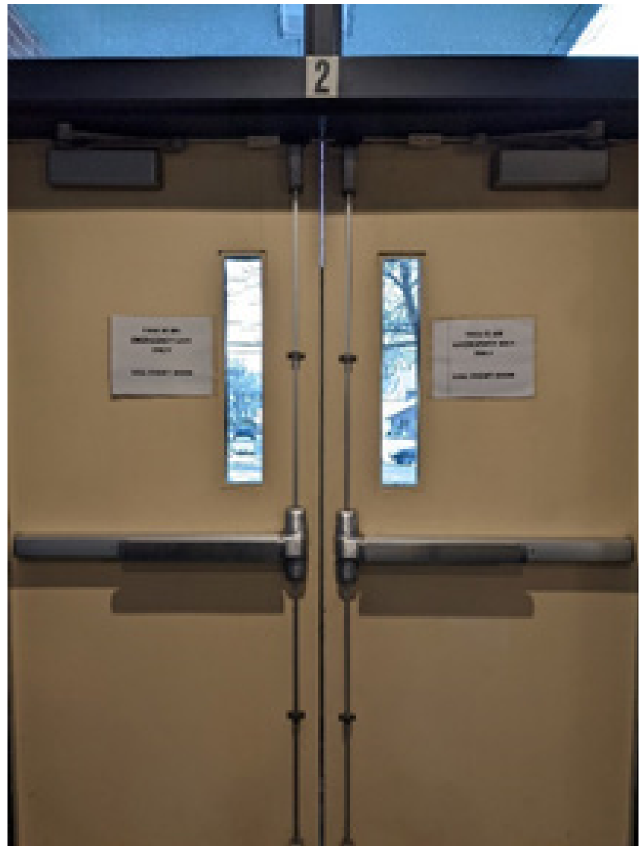


Figure 1 and 2 ***Example Infiltration at Peirce Elementary School***

Baseline Energy Profile & Emissions

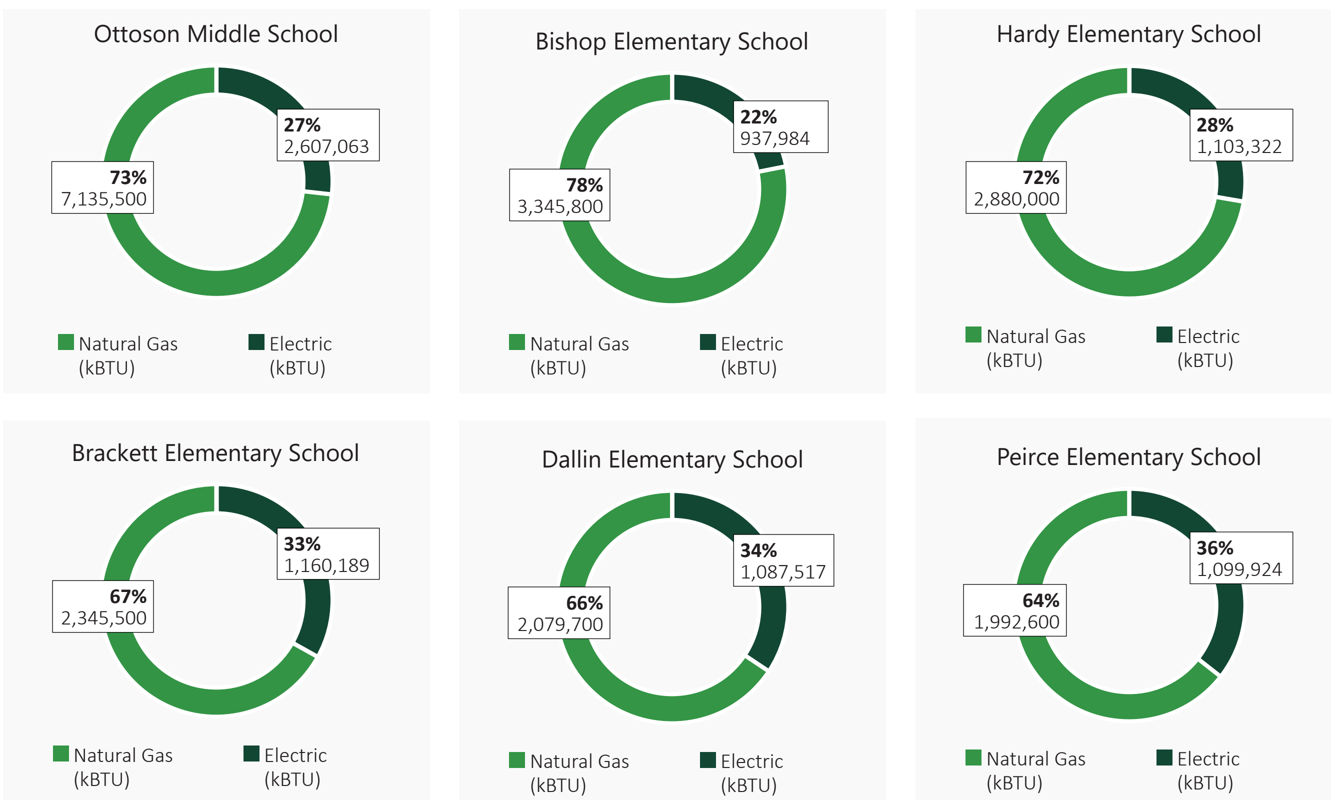
The following is a summary of the pre-electrification energy of each school. This data acts as a baseline to which future improvements can be compared. This section will describe the baseline energy use, energy use intensity, energy cost, and emissions for the six school buildings.

Energy Use

In 2019, for the six schools, the Town paid a combined ~$811,000 for utilities, with electricity accounting for 72% and gas accounting for the remaining 28% of the total cost. Aggregate annual utility costs come to $1.84 per square foot.

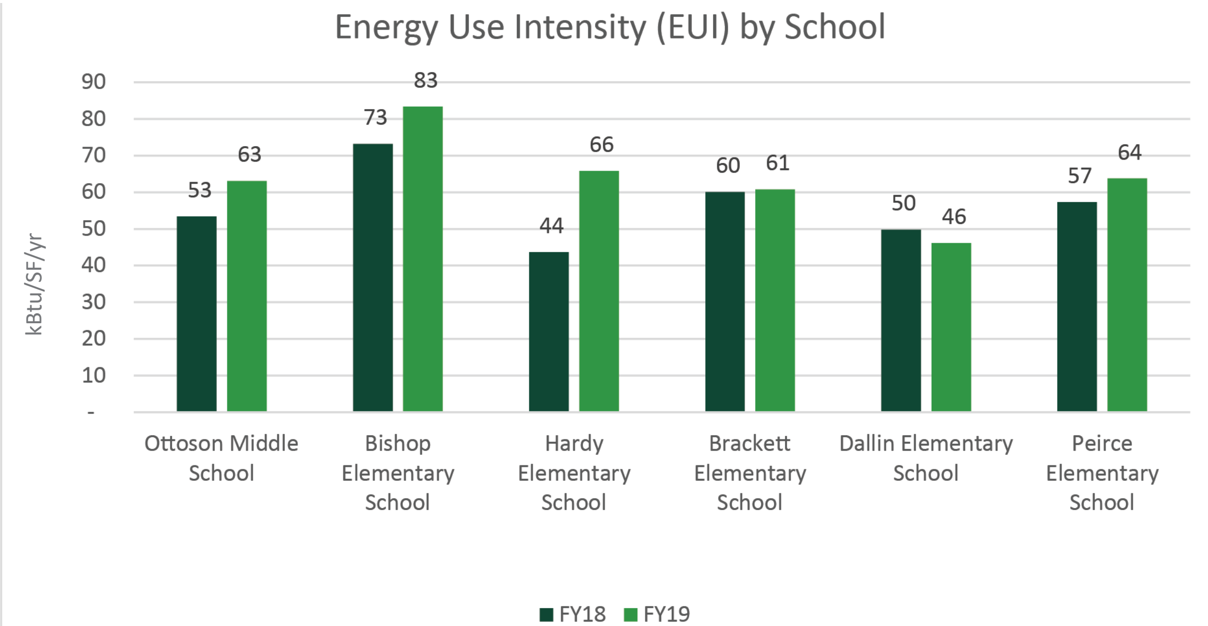
The following charts show the proportion of electricity verses natural gas consumption in 2019. For ease of comparison, both sources of energy have been converted from their native units, kilowatt hours (kWh) and therms, to kilo British thermal unit (kBTU).

School Energy Consumption of Gas vs. Electricity (2019)

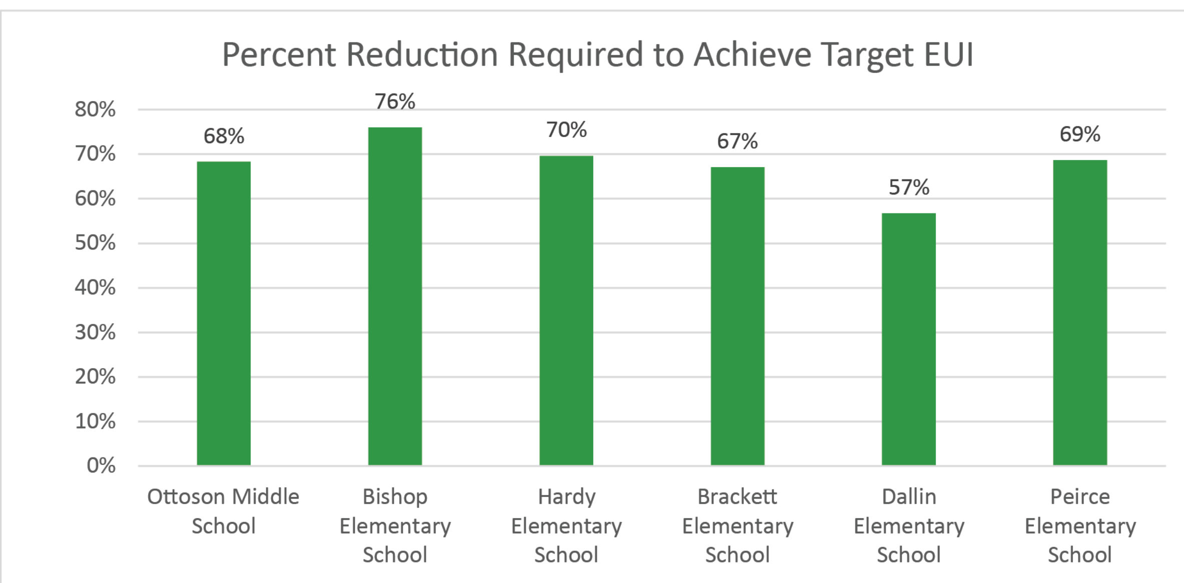


Energy Use Intensity

Building efficiency is measured in thousands of British Thermal Units per square foot per year (kBtu/SF-yr). This metric is referred to as Energy Use Intensity (EUI). This allows the energy consumption for buildings of various sizes to be fairly compared with a normalized metric. The lower the EUI, the better. Arlington's six schools operated at a site EUI ranging from 44-83 kBtu/SF/yr in fiscal years 2018 and 2019, as depicted in the graph below.



A net zero energy school would also be net zero emissions. For comparison to the current school EUIs, the target EUI for a net zero energy school is 20-25. For the six schools in this study to reach that target EUI range, overall energy would need to be reduced. As shown in the chart below, to achieve the net zero target EUI of 20-25, the total energy consumption of each school would need to be reduced 57-76%.



Energy reduction required when comparing the current building EUI with the target EUI required for net zero energy

Utility Rates and Costs

Arlington currently utilizes two primary energy sources for its school buildings: electricity and natural gas.

Arlington's electricity distributor is Eversource. Arlington has a fixed-price (no separate capacity charge) competitive electricity contract with Constellation that expires in December 2024. Arlington negotiates new competitive supply contracts approximately every three years.

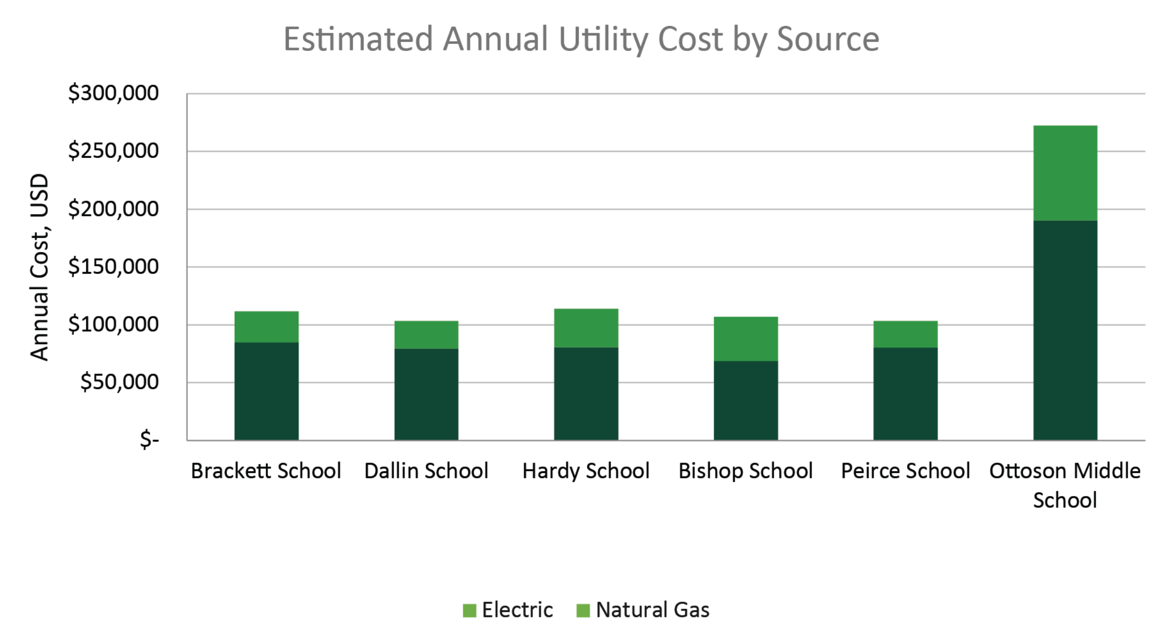
Arlington's natural gas distributor is National Grid. Arlington has a competitive gas supply contract with Direct Energy that expires in October 2024. Arlington negotiates new competitive supply contracts approximately every three years. Recent rates for both utilities, as provided by Town staff, are below.

Utility	Time Period	Supply Rate
Electricity	Dec 2019 – Dec 2022	$0.1023 / kWh
	Dec 2022 – Dec 2023	$0.0862 / kWh
	Dec 2023 – Dec 2024	$0.1285 / kWh
Natural Gas	Jan 2020 – Dec 2022	$0.573 / therm
	Jan 2023 – Oct 2024	$0.492 / therm

When accounting for supply and delivery, the blended rates for FY22 are shown below. These are the average across the six schools included in this analysis.

Blended Rate	
Electricity	Natural Gas
$0.2491 / kWh	$1.15 / therm

Most of the utility costs for each school are from the electricity. The consumption distribution is the converse; a majority of the energy is from natural gas while it accounts for a minority of the costs. This is a well-known market condition. The approach of this study is efficiency first, then electrification. This will enable the Town to achieve its sustainable electrification goals without prohibitive costs. The graph below shows the estimated annual utility cost for each school by energy source, using the blended rate and FY2019 energy use.



Emissions Analysis

Emissions are quantified based on fuel portfolio and annual consumption. Though the cost of electricity is higher, the emissions associated with electricity are lower. As more renewable energy comes online, grid emissions will continue to trend lower. Natural gas is the cheaper fuel, but it comes at the cost of higher levels of on-site pollution. The analysis below quantifies emissions based on EPA provided emission factors for electricity and natural gas consumption. The national emissions factor for electricity is 1 kilowatt hour = 0.000433 Metric tons of carbon dioxide equivalent (MTCDE). However, the Independent System Operator New England (ISO-NE) grid is cleaner than the national average, so this analysis utilized the ISO-NE regional value (below). Natural gas combustion occurs onsite and is thus not regionally dependent. The natural gas emissions factor is the national value. This value does not account for fugitive methane emissions.

ELECTRIC

1 kWh (kilowatt hour) = 0.00026 MTCDE (regional)

NATURAL GAS

1 therm = 0.00553 MTCDE (national)

For perspective on potential carbon cost, the analysis used the proposed "cost" of carbon, $234/MTCDE, as laid out in the Boston Emissions Reduction Disclosure Ordinance (BERDO 2.0). The BERDO program is from the same geographic region and is one of the most realized emissions strategies in the country. Using the 2019 utlity data and the BERDO carbon cost, the estimated cost of not electrifying or seeking clean power would be about $400,000 per year. Townwide emissions from the six schools are summarized in the table below.

TOTAL FOR 6 SCHOOLS STUDIED

Total Emissions

1,700 MTCDE

(2019 Baseline Emissions)

Equivalent Emissions

200 US Homes
(Over one year)

OR

400 Vehicles
(Driven over one year)

Offset Costs

$400,000/yr

Estimated annual cost of carbon offsets starting in 2030 if baseline emissions are not reduced, using the proposed BERDO $234/MTCDE.

The following page breaks out the emissions for each school in the study. The annual carbon footprint is shown in MTCDE and was calculated using utility data from 2019. Using 2019 data reflects typical energy consumption patterns, while more recent years did not reflect typical operating hours or control settings due to adaptations for the COVID-19 pandemic.

For each school, as for the total noted in the figure above the footprint was converted to more recognizable units, such as the emissions from an average US home or an internal combustion engine vehicle, driven for one year. This was done with the EPA's greenhouse gas equivalency calculator.

Ottoson Middle School

600 MTCDE
(2019 Baseline Emissions)

Equivalent Emissions

75 US Homes
(Over one year)

128 Vehicles
(Driven over one year)

Bishop Elementary School

260 MTCDE
(2019 Baseline Emissions)

Equivalent Emissions

32 US Homes
(Over one year)

55 Vehicles
(Driven over one year)

Hardy Elementary School

240 MTCDE
(2019 Baseline Emissions)

Equivalent Emissions

31 US Homes
(Over one year)

52 Vehicles
(Driven over one year)

Brackett Elementary School

220 MTCDE
(2019 Baseline Emissions)

Equivalent Emissions

27 US Homes
(Over one year)

47 Vehicles
(Driven over one year)

Dallin Elementary School

200 MTCDE
(2019 Baseline Emissions)

Equivalent Emissions

25 US Homes
(Over one year)

43 Vehicles
(Driven over one year)

Peirce Elementary School

190 MTCDE
(2019 Baseline Emissions)

Equivalent Emissions

24 US Homes
(Over one year)

42 Vehicles
(Driven over one year)

Ottoson Middle School

63 Acton Street, Arlington, MA 02476

BUILDING HIGHLIGHTS

SIZE
- 154,380 SF
- 42 Classrooms
- 899 Students

CONSTRUCTION
- Constructed in 1920, major renovations in 1998

BUILDING ENVELOPE
- Windows are double pane
- Windows were open in many classrooms
- Roof replaced in 1998
- Infiltration through gaps in exterior doors

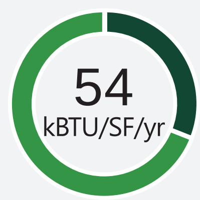
MECHANICAL EQUIPMENT
- Gas-fired domestic water (DW) heating and hot water (HW) heating boilers (x3)
- General Classrooms & Instructional Spaces – Heating Only Unit Ventilators (UV)
- Band, Cafeteria/Dining, Admin/Offices - Large DX A/C Rooftop Units (RTU) w/ Natural Gas Heat (Multizone & Single Zone)
- Media Center & Media Center Support Areas – Self-Contained DX Unit Ventilators & DX A/C RTUs
- Gyms, Shop, Locker Rooms – Heating and Ventilation Air Handling Units (AHU)

ELECTRICAL EQUIPMENT
- The current service is 4000A 3-phase 208/120V
- 9.3 W/SF, which is of adequate size
- Has 270 kW rooftop solar; there is room for additional installations

KITCHEN EQUIPMENT
- Kitchen currently used primarily for warming

ENERGY BENCHMARKING [2019 DATA]

Annual EUI



Electrical Usage
2,607,063 kBTU *(31% of EUI)*

Natural Gas Usage
5,741,500 kBTU *(69% of EUI)*

Greenhouse Gas Emissions
476.1 metric tons CO2e

49
energy
Energystar Score

EQUIVALENT MEDIAN K-12 SCHOOL

Annual EUI

53.6
kBTU/SF/yr

EQUIVALENT ENERGYSTAR K-12 SCHOOL

Min. Annual EUI

40.5
kBTU/SF/yr

Bishop Elementary School

25 Columbia Road, Arlington, MA 02474

BUILDING HIGHLIGHTS

SIZE
- 51,367 SF
- 15 Classrooms
- 440 Students

CONSTRUCTION
- Constructed in 1950, major renovations in 2002

BUILDING ENVELOPE
- Significant air gaps at most exterior doors
- Windows are double pane
- Windows were open in many classrooms, many shades were drawn

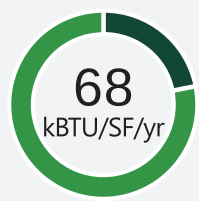
MECHANICAL EQUIPMENT
- Natural Gas-fired DW Heating and HW heating boilers (x2)
- General Classrooms & Instructional Spaces- Heating and Ventilating RTUs w/duct HW coils & w/ FTR
- General Classrooms & Instructional Spaces (Addition) – VRF with ERVs
- Admin, Offices, Media Center, Computer Lab- RTUs w/ split DX A/C coils & w/ duct HW coils
- Gym – Heating and Ventilating AHU

ELECTRICAL EQUIPMENT
- The current service is 1200A 3-phase 208/120V
- 8.4 W/SF, this ratio is low. A new service would likely be required.
- No onsite solar PV

KITCHEN EQUIPMENT
- Kitchen currently used primarily for warming

ENERGY BENCHMARKING [2019 DATA]

Annual EUI



Electrical Usage
937,984 kBTU (*27% of EUI)*

Natural Gas Usage
2,566,000 kBTU *(73% of EUI)*

Greenhouse Gas Emissions
197.9 metric tons CO2e

46

Energystar Score

EQUIVALENT MEDIAN K-12 SCHOOL

Annual EUI

65.6
kBTU/SF/yr

EQUIVALENT ENERGYSTAR K-12 SCHOOL

Min. Annual EUI

49.6
kBTU/SF/yr

Hardy Elementary School

52 Lake Street, Arlington, MA 02474

BUILDING HIGHLIGHTS

SIZE
- 60,507 SF
- 14 Classrooms
- 444 Students

CONSTRUCTION
- Constructed in 1926, major renovations in 2001
- 6-classroom addition in 2018

BUILDING ENVELOPE
- Significant air gaps at most exterior doors
- Windows are double pane
- Roof partially painted white for reduced heat gain
- Roof replaced in 2001

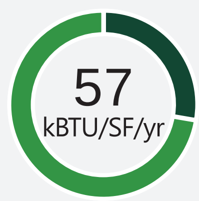
MECHANICAL EQUIPMENT
- Natural gas-fired DW heating and HW boilers (x2)
- General Classrooms & Instructional Spaces – Heating and Ventilating RTUs w/duct HW coils & w/ FTR
- General Classrooms & Instructional Spaces (Addition) – VRF with ERVs
- Admin, Offices, Media Center, Computer Lab- RTUs w/ split DX A/C coils & w/ duct HW coils
- Gym – Heating and Ventilating AHU

ELECTRICAL EQUIPMENT
- The current service is 1200A 3-phase 208/120V
- 7.1 W/SF, this ratio is low. A new service would likely be required
- There have been lighting retrofits including motion/ occupancy sensors
- No onsite solar PV

KITCHEN EQUIPMENT
- Kitchen currently used primarily for warming

ENERGY BENCHMARKING [2019 DATA]

Annual EUI



Electrical Usage
1,103,322 kBTU (*32% of EUI*)

Natural Gas Usage
2,370,200 kBTU (*68% of EUI*)

Greenhouse Gas Emissions
198.3 metric tons CO2e

54

Energystar Score

EQUIVALENT MEDIAN K-12 SCHOOL	EQUIVALENT ENERGYSTAR K-12 SCHOOL
Annual EUI	Min. Annual EUI
60.1 kBTU/SF/yr	45.4 kBTU/SF/yr

Brackett Elementary School

66 Eastern Avenue, Arlington, MA 02476

BUILDING HIGHLIGHTS

SIZE
- 57,670 SF
- 20 Classrooms
- 535 Students

CONSTRUCTION
- Constructed in 2000, no major renovations

BUILDING ENVELOPE
- Windows are double pane, but a number of them had blown seals
- Many windows were open
- Roof replaced in 2000
- Infiltration through gaps in exterior doors

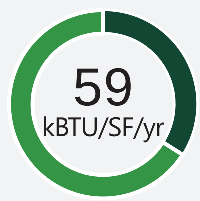
MECHANICAL EQUIPMENT
- Natural gas-fired domestic water heating and HW heating boilers (x2)
- General Classrooms & Instructional Spaces – Heating and Ventilating RTUs w/HW coils & w/ VAVs & w/ FTR
- Admin, Offices, Media Center, Computer Lab – DX A/C RTU w/ HW coil & w/ VAVs & w/ FTR
- Gym – Heating and Ventilating RTU w/HW coil

ELECTRICAL EQUIPMENT
- The current service is 1200A 3-phase 480/277V
- 17.3 W/SF, which is of adequate size
- Has been completely retrofit with LED lighting
- No onsite solar PV

KITCHEN EQUIPMENT
- Kitchen currently used primarily for warming

ENERGY BENCHMARKING [2019 DATA]

Annual EUI



Electrical Usage
1,160,189 kBTU *(34% of EUI)*

Natural Gas Usage
2,345,500 kBTU *(66% of EUI)*

Greenhouse Gas Emissions
195.1 metric tons CO2e

50

Energystar Score

EQUIVALENT MEDIAN K-12 SCHOOL

Annual EUI

59
kBTU/SF/yr

EQUIVALENT ENERGYSTAR K-12 SCHOOL

Min. Annual EUI

44.7
kBTU/SF/yr

Dallin Elementary School

185 Florence Avenue, Arlington, MA 02476

BUILDING HIGHLIGHTS

SIZE
- 68,578 SF
- 15 Classrooms
- 472 Students

CONSTRUCTION
- Constructed in 1956, major renovations in 2005

BUILDING ENVELOPE
- Significant air gaps at most exterior doors
- Windows are double pane
- Windows were open in many classrooms
- Roof replaced in 2005

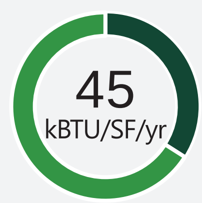
MECHANICAL EQUIPMENT
- Natural gas-fired domestic water heating and HW heating boilers (x3)
- General Classrooms & Instructional Spaces – Heating Only Unit Ventilators
- Cafeteria/Dining, Admin/Offices, Media Center- DX A/C Rooftop Units w/ Natural Gas Heat
- Gym – Heating and Ventilating AHUs

ELECTRICAL EQUIPMENT
- The current service is 1200A 3-phase 480/277V
- 14.5 W/SF, which is of adequate size
- Has 120 kW rooftop solar

KITCHEN EQUIPMENT
- Kitchen currently used primarily for warming

ENERGY BENCHMARKING [2019 DATA]

Annual EUI



Electrical Usage
1,087,517 kBTU *(35% of EUI)*

Natural Gas Usage
1,987,100 kBTU *(65% of EUI)*

Greenhouse Gas Emissions
176.5 metric tons CO2e

71

Energystar Score

EQUIVALENT MEDIAN K-12 SCHOOL

Annual EUI

56.5
kBTU/SF/yr

EQUIVALENT ENERGYSTAR K-12 SCHOOL

Min. Annual EUI

42.7
kBTU/SF/yr

Peirce Elementary School

85 Park Avenue Extension, Arlington, MA 02474

BUILDING HIGHLIGHTS

SIZE
- 48,500 SF
- 12 Classrooms
- 307 Students

CONSTRUCTION
- Constructed in 2002, no major renovations

BUILDING ENVELOPE
- Significant air gaps at most exterior doors
- Windows are double pane
- Windows were open in many classrooms

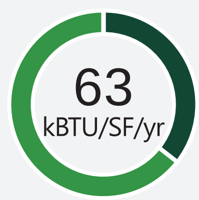
MECHANICAL EQUIPMENT
- Natural gas-fired domestic water heating and hot water heating boilers (x3)
- Air-Cooled Chiller
- General Classrooms & Instructional Spaces – 2-Pipe Heating/Cooling Unit Ventilators
- Cafeteria/Dining, Admin/Offices, Media Center – AHUs with Cooling
- Gym – Heating and Ventilating AHUs

ELECTRICAL EQUIPMENT
- The current service is 1200A 3-phase 480/277V
- 20.6 W/SF, which is of adequate size
- Has been completely retrofit with LED lighting
- Has 80 kW rooftop solar

KITCHEN EQUIPMENT
- Kitchen currently used primarily for warming

ENERGY BENCHMARKING [2019 DATA]

Annual EUI



Electrical Usage
1,099,924 kBTU (*36% of EUI)*

Natural Gas Usage
1,099,924 kBTU *(64% of EUI)*

Greenhouse Gas Emissions
176.3 metric tons CO2e

45

Energystar Score

EQUIVALENT MEDIAN K-12 SCHOOL

Annual EUI

60.1
kBTU/SF/yr

EQUIVALENT ENERGYSTAR K-12 SCHOOL

Min. Annual EUI

45.5
kBTU/SF/yr

PHASE II
ALTERNATIVE ELECTRIFICATION & AIR QUALITY IMPROVEMENT OPTIONS

PHASE II OBJECTIVES

This section describes options, feasibility, and priorities for drastic energy reductions and electrification at each site while adding air conditioning and mechanical ventilation throughout. As part of this effort, a Scoping Study Narrative (Appendix A), annotated PDF floor plans (Appendix B), cutsheets (Appendix C), and cost estimates (Appendix D) were prepared for each site. This portion of the Master Plan describes the technical approach necessary at a concept level for each school. Each of the schools will require significant minimum investment for HVAC system replacement in the next 20 years.

The basis of the Master Plan utilizes the following building information:

a. Bishop Elementary School – 51,370 SF
b. Brackett Elementary School – 57,670 SF
c. Dallin Elementary School – 68,580 SF
d. Hardy Elementary School – 60,510 SF
e. Peirce Elementary School – 48,500 SF
f. Ottoson Middle School – 154,400 SF

Additionally, increases in occupancy are not anticipated nor are building expansions included in this Master Plan. The CMTA team recommends that Ottoson Middle School undergo a more comprehensive update/renovation through the MSBA Capital Planning Process based on the overall age and condition of the building.

Two HVAC systems are considered in detail for each site: water-cooled, closed-loop ground source/geo-exchange HVAC and air-cooled variable refrigerant flow (VRF). An "in-kind" option that leaves existing natural gas heat and adds complete air conditioning is included to show the minimum investments that will be needed by the Town regardless of final HVAC system selection approach, recognizing that full renewal of existing systems will be needed in the near future. Both electrification approaches include total system renewal of equipment, piping ductwork, controls, etc. not just individual pieces of equipment.

The ground source HVAC system and VRF system options include full air conditioning and full heating. There are hybrid options available between the systems, and standing column geothermal wells could be considered, but these additional options were not included in this analysis. Both the ground source and VRF systems include mechanical dedicated fresh air ventilation complying with ASHRAE 62.1 and post-pandemic filtration strategies. Sizing of the HVAC system assumes air infiltration reduction measures but not major envelope upgrades. Also, alternatives to electrify domestic water heating are described and the food service approach of "warming kitchens" in the schools is assumed to remain – this is an effective strategy from an energy efficiency perspective.

The analyses of the systems incorporate first cost estimates, anticipated annual operating costs, and carbon emissions potential, in order to establish a life cycle cost investment. There are also potential utility incentives and federal tax dollars that may be available depending on the option chosen.

Path Forward to Electrification & Net Zero Emissions

The Town considered including a goal of net zero energy as well as net zero emissions, but ultimately that reality is limited by available real estate for PV systems and the feasibility of drastic energy reductions in existing buildings. A net zero energy building, as defined by the Department of Energy in its publication "A Common Definition for Zero Energy Buildings," is "an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy." In the industry, the goal EUI for a zero-energy building is the 20-25 EUI range, or better. This range represents a good ratio of program square footage, which drives energy consumption, to roof area, which typically limits the amount of PV that can be installed on site. To acheive an EUI in this range in an existing building will require drastic reductions in energy consumption. For the Arlington schools, based on the most recent energy data and the expectation of adding air conditioning to the buildings, this focus on energy efficiency first is especially necessary.

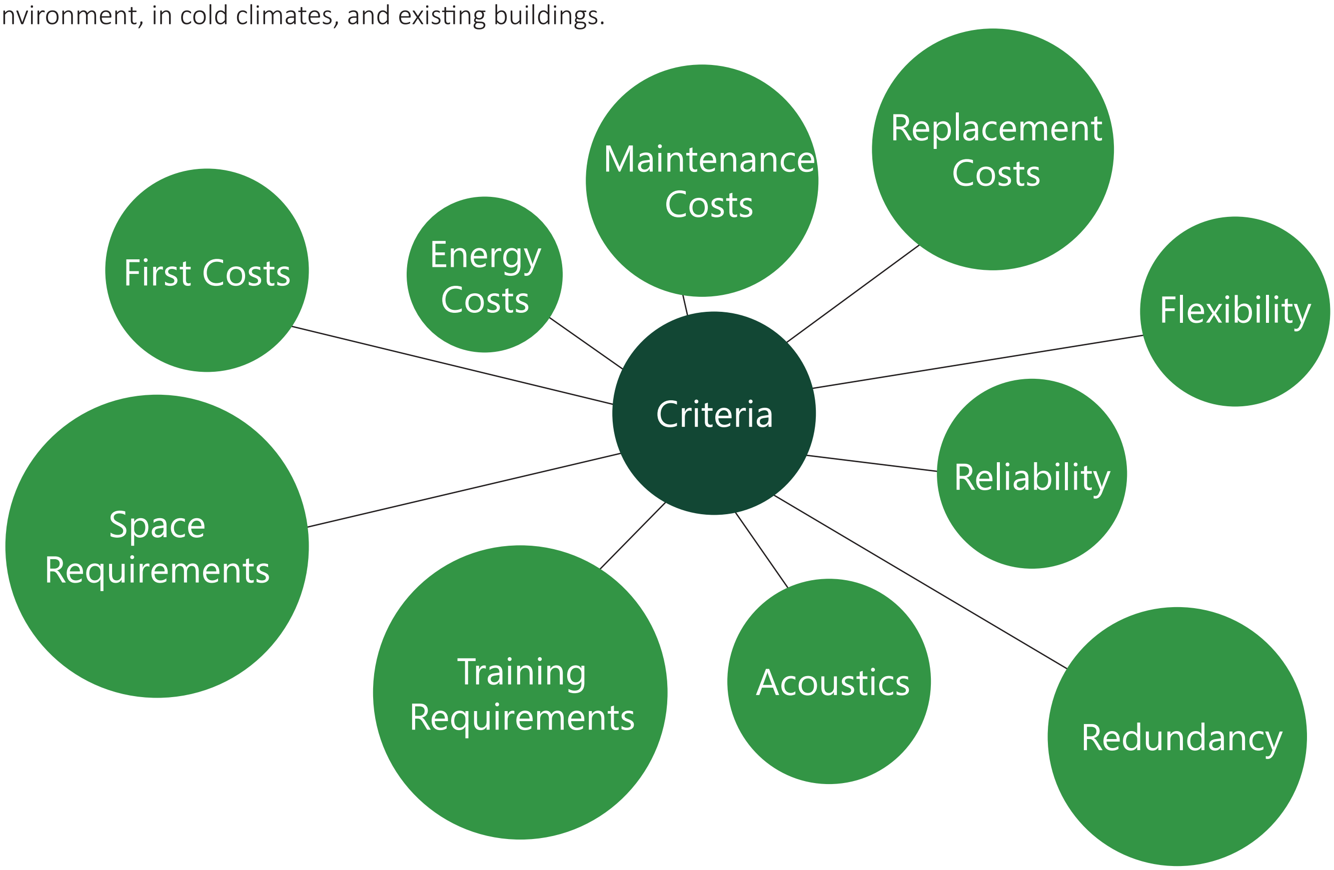
The following strategies, many of which the Town has taken, support energy reduction. Steps to enable the electrification of existing buildings:

1. Install highly efficient electrified heat pump type HVAC systems including controls and energy recovery strategies.
2. Install highly efficient LED lighting and controls.
3. Improve building envelope's thermal performance and reduce air leakage rates.
4. Install highly efficient electrified domestic hot water heating systems and implement water conservation strategies.
5. Manage plug loads including office equipment, technology systems and kitchen equipment and appliances.
6. Install additional on-site energy generation and/or purchase clean energy.
7. Verify the building performance through optimized commissioning efforts and consistently optimize building operations through long term measurement and verification.

Energy efficiency and reduction are central to net zero emissions as well as net zero energy, so each of these strategies has been considered in this study. Specific recommendations are broken out by building systems later in this section.

HVAC Electrification Alternatives

The largest operational cost impacts related to electrification will come down to the HVAC system selection. Several factors must be considered when selecting an HVAC system, as is depicted in the following diagram. There are several electric heat pump HVAC system options, but not all are a good fit when considering a K-12 environment, in cold climates, and existing buildings.



After conversations with the Town at the commencement of this study, it was decided that there would be two heat pump electrification options considered in this Master Plan. Both options will completely convert the natural gas-fired HVAC systems to electrified systems.

OPTION 1

Air-Cooled Variable Refrigerant Flow (VRF) HVAC System

This option consists of indoor cassette units, fan coils, etc. with outdoor VRF compressor heat pump units and interconnecting refrigerant piping for zone heating/cooling control. This system has a lower first costs, but higher life cycle costs. The predicted EUI for any school with this system will be ≈45 EUI.

OPTION 2

Water-cooled, Closed-loop Ground Source Heat Pumps

This option consists of unitary water-source heat pumps for zone heating/cooling control and an underground closed loop geothermal wellfield. This system has a higher first costs, but lower life cycle costs. The predicted EUI for any school with this system will be ≈22 EUI.

In response to COVID-19, both options include dedicated ventilation (outside) air systems to deliver preconditioned and highly filtered fresh air to all occupiable spaces.

Criteria Prioritization

There are many criteria by which the HVAC system could be chosen. The table below shows the parameters typically most important to school districts and how the two systems compare to one another.

	VRF	Geothermal
First cost	✓	X
EUI	X	✓
Program Implications/Space Required	✓	X
Speed of Construction	✓	X
Indoor Air Quality/Filtration	X	✓
Operating Cost	X	✓
Individual Zoning	✓	X
Emission Implications	X	✓
Fewer Compressors	✓	X
PV Impact	X	✓
Refrigerant Global Warming Potential (GWP)	X	✓

Parameters are explained below.

First Cost: The initial cost to purchase and install a new system.

The installation and equipment required for a VRF system is typically less expensive than a geothermal system.

EUI: The average Energy Use Intensity of an elementary school with this system type.

Geothermal heatpumps are a more efficient system and thus typically have a lower EUI than the same building with a VRF system.

Program Implication/Space Required: This refers to the total amount of equipment, its size, and the ideal location. In an existing building, there are are direct tradeoffs between mechanical/electrical space and program space.

In a VRF system, most equipment is confined to central mechanical rooms, above ceiling, and rooftops, meaning there is little reduction in program space. In geothermal heat pump systems, it is favorable for maintainance to locate the heat pumps in closets rather than above ceiling. Depending on the layout of the school, this can mean taking some area from program space.

Speed of Construction: The total time to install the system and return the space to operable conditions.

A geothermal system requires the drilling of a wellfield. This additional step means that VRF installations take less total time.

Indoor Air Quality: The quality of air in the building; related to the health and comfort of occupants.

Both systems can be equipped with air filters of the desired rating (post-COVID, this is typically MERV-13). However, because the heat pumps are installed in closets with separate doors to the hallway wherever possible, rather than above ceiling, they are more easily accessible for maintenance. In many cases, filter changes and other maintenance can be conducted more frequently without distrupting classrooms.

Operating Cost: The cost of utilities to operate the building.

Geothermal systems are more efficient than VRF, leading to lower energy consumption and decreased utility bills.

Individual Zoning: The degree to which occupants can control the thermal conditions of their space.

In geothermal systems, one to three zones share a heatpump, but individual airflow control per zone is still provided.

Emission Implications: The expected emissions based on the system type.

In this case, both systems would be all electric, so site emissions would be equivalent. However, at a source level, grid electricity is not yet 100% clean, so the better option is the one that uses the least electricity. As noted in the operating cost description, a geothermal system means higher efficiency, lower EUI, and less total energy consumption.

Fewer Compressors: This is based on the sum of all compressors required for either system.

Every heat pump includes a compressor, while a VRF system would only have compressors in the central outdoor equipment.

PV Impact: If striving for net zero energy, then a school would install an amount of PV capable of producing as much energy as the building consumes. The design and performance of the HVAC system is a large driver of the PV sizing.

The higher efficiency of the geothermal system means a smaller PV system would be required.

Refrigerant GWP: The global warming potential and amount of refrigerant required for either system.

Both systems could use the same refrigerant type, so the GWP would not vary. However, the VRF system is refrigerant based and thus requires a larger total amount of refrigerant. VRF also has more risk for leakage during field installation of refrigerants.

Phasing Recommendations

The culmination of the information gathered in Phases I & II is a weighted average computation. This method allowed quantitative assignments to be made across the key categories: Original Construction, Renovation, Equipment Condition, Energy Use Intensity, Carbon Footprint, and Current Operating Cost/SF. In each category, schools were ranked from 1-6 with 1 representing either the oldest, or worst condition and 6 the newest, or best condition. Ultimately, the data was condensed into three categories:

1. Need for Renewal: Based on the age of building and condition of infrastructure
2. Carbon Footprint: Based on total emissions using 2019 utility data
3. First Cost: Based on first cost of the existing heat and DX cooling case (1 is the highest cost, 6 the lowest cost)

Applying weights to the data allows for the conversion of qualitative comparisons to quantitative ones. Through discussions with the Town, it was decided to include Need for Renewal just above Carbon Footprint and First Cost, which resulted in weights of 40%, 30%, and 30%, respectively.

	1. Need for Renewal	2. Carbon Footprint	3. First Cost	Overall Rank
Bishop Elementary School	4	2	5	2
Brackett Elementary School	2	4	4	3
Dallin Elementary School	6	5	2	6
Hardy Elementary School	3	3	3	4
Peirce Elementary School	5	6	6	5
Ottoson Middle School	1	1	1	1*

The resulting order can be seen above. Ottoson is ranked first, but it is our recommendation that it be treated differently. Given the overall age of Ottoson, equipment, and the disparate layout of the various wings, an HVAC retrofit does not make sense as a standalone project. Funds invested to put a new HVAC system into the building would be better spent on a more comprehensive and integrated upgrade. In coordination with the MSBA, funds could be requested for said upgrade. With that note, the following is the recommended order to address the schools:

1. Ottoson Middle School (pending MSBA funding, Ottoson could change priority)
2. Bishop Elementary School
3. Brackett Elementary School
4. Hardy Elementary School
5. Peirce Elementary School
6. Dallin Elementary School

Clean Power

Existing Conditions

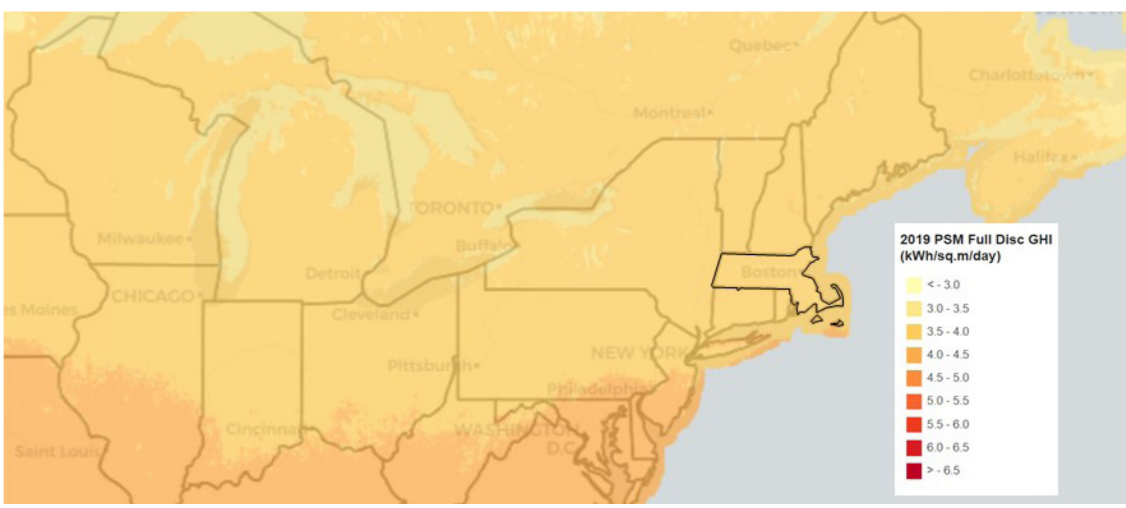
Three of the schools studied have existing PV installations: 120 kW at Dallin Elementary, 80 kW at Peirce Elementary, or the 230 kW at Ottoson Middle School. These are a part of a 2015, 20-year solar power purchase agreement with Ameresco. These installations are all in front of the meter and the Town does not claim the environmental offset.

A renovation of Arlington High School occurred in parallel with this Master Plan. During construction of that project, the rooftop panels had to be disconnected and temporarily relocated. The Town incurred fees for the period during which the panels were out of commission and not generating power. This was brought to the attention of the CMTA as a consideration for potential impacts on current or future rooftop solar at the six schools studied.

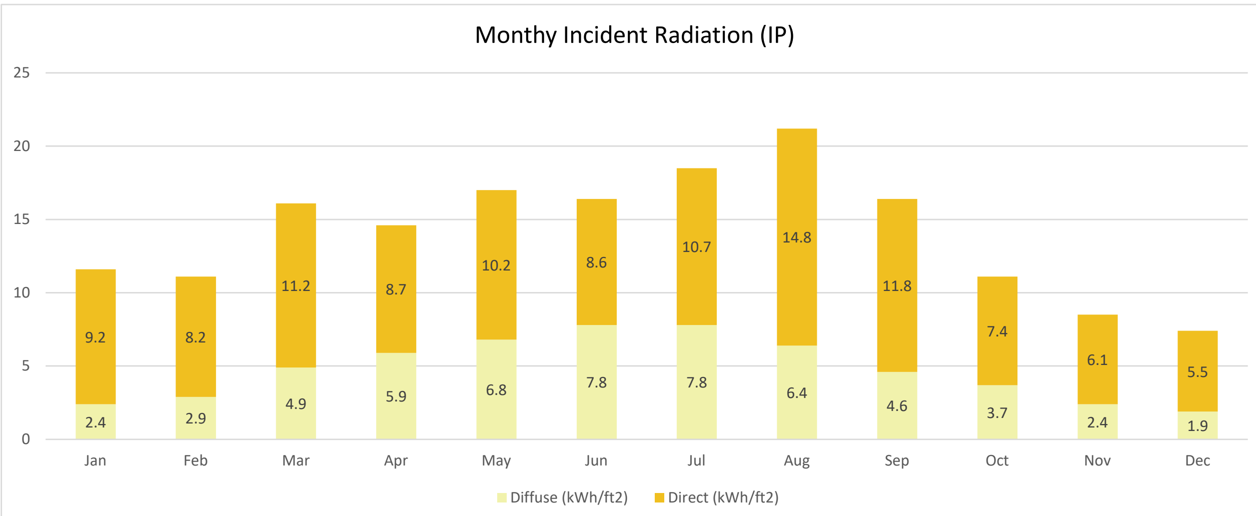
For those three schools with solar, electrification project construction could be conducted without long-term disruption to generation or the need for panel relocation. Temporary disconnects may need to occur when new equipment is being connected and short-term disconnection may be required if a service upgrade is deemed necessary. This would be confirmed in the design phase of each the projects. Regarding relocation, the removal of existing rooftop units is feasible without disruption of the PV installations. Based on dimensions from cutsheets for the new rooftop equipment, such as the dedicated outdoor air system (DOAS) unit, it is feasible to place new equipment within the footprint of the removed equipment. This would negate the need to reconfigure the arrays. This would also require confirmation when equipment is specified.

Solar Potential

Analysis of the sites was performed to determine if solar access and typical weather conditions are suitable for solar photovoltaics. The variables of interest included global horizontal irradiance (GHI), direct normal irradiance, diffuse horizontal irradiance, and ambient temperature. Data from NREL's National Solar Radiation Database (NSRDB) was used to assess typical conditions for the proposed site. These variables are necessary for calculating the irradiance available to PV arrays and can serve as a proxy for preliminary assessments of solar PV production. GHI is the total amount of sunlight available at the Earth's surface, including both the direct and diffuse components of sunlight. The average annual GHI for Massachusetts is 3.8 kWh/sq.m/day. The map below indicates the average daily horizontal irradiance available across Massachusetts and neighboring states.



Through the data obtained from the NSRDB, an annual profile of solar irradiation was created, as shown in the figure below. Due to the site locations, photovoltaic solar systems have the potential to produce a significant amount of electrical energy. While high ambient temperatures can reduce a PV array's power output, the maximum average monthly temperature for Massachusetts is only three degrees Celsius higher than standard testing conditions for PV modules. At the maximum temperature of 96.8 degrees Fahrenheit, module performance would only be expected to depreciate by 1.2%. These factors combine to make the sites suitable location for solar PV systems.



To understand the site solar potential, Helioscope models were created for each site. This is the same tool utilized by Ameresco in their previous solar study. The higher solar potential found in our study can be attributed to the continued advancement in solar panel efficiency. The models used 450W modules. The total solar potential of each school, using 2022 solar panels, is shown in the chart below. The existing solar arrays at Dallin, Peirce, and Ottoson take up a majority of the rooftop square footage, leaving limited space for new installations. Given that those installations are set to stay installed through 2035, the actual install potential was recalculated. The "Actual Install Potential" column reflects the amount of solar that could be installed but should be verified when the system is designed. Lastly, the EUI Offset shows the equivalent offset from the actual install potential.

Site	2022 Rooftop PV Potential	Existing PV Install	Actual Install Potential	EUI Offset
Bishop Elementary School	187 kW	-	187 kW	14
Brackett Elementary School	191 kW	-	191 kW	12
Dallin Elementary School	271 kW	120 kW	69 kW	4
Hardy Elementary School	226 kW	-	226 kW	14
Peirce Elementary School	198 kW	80 kW	70 kW	5
Ottoson Middle School	613 kW	230 kW	341 kW	8

For Option 1 (VRF), to achieve a net zero energy building at the target EUI of 45, then the average solar array for each of the six schools would be 1034 kW in size. For Option 2 (geothermal), to achieve a net zero energy building at the target EUI of 22, the average solar array for each of the six schools would be 521 kW in size. In no case is the amount of feasible rooftop solar enough to fully offset the predicted EUI of either system.

Clean Energy Procurement

In Massachusetts, electric and/or gas customers can compare pricing among competing energy commodity providers. Energy reforms and market competition bring lower, more flexible energy prices with new service offerings designed to attract and keep customers. These reforms are the result of energy market deregulation, where consumers are empowered to compare rates, services, and contract terms, and then choose the options that are best for them.

Purchasing renewable energy could provide a relatively simple way to offset electricity emissions for the Town. Renewable energy can often be purchased directly from the customer's load-serving utility, or from a specialized service provider. This is a widespread and familiar compliance strategy for many organizations with renewable energy goals. This could be an improvement made in the interim period between the present and full electrification. This strategy could continue to be employed post-electrification, to offset the emissions of electricity from the grid until the point at which the grid is completely clean. Eversouce and the State of Massachusetts have made commitments to green the grid by 2050.

Clean Energy Recommendations

Initial area evaluations indicated that Town would need to accommodate approximately 3-6 MW of roof-mounted and ground-mounted solar PV to fully offset energy consumed across the 6 schools. In cases where on-site generation is limited by technical or economical limitations, procurement strategies should be adopted to reduce emissions from purchased electricity.

Reaching net zero energy on site is not likely feasible. The potential for a community solar installation, which would be sized to total any required solar that could not be accomodated at the six school sites, was then put forth. The size of such an installation would have been more than a few acres and such real estate is not available in the town.

For the Town to reach its net zero emissions goal, with the constraints above, the best option could be clean energy procurement. This solution would allow the Town an intermediate solution until the grid is 100% clean. The approach would remain: pay attention to energy efficiency first, designing and maintaining electrified schools with the lowest possible EUI. Then, the Town would procure clean energy to offset the GHG emissions associated with the grid electricity used. As the grid becomes cleaner, the amount of clean energy required as an offset would decrease until it is no longer necessary.

Building Operations & **Performance**

With the financial investment required for these facilities, hands-on commissioning and optimization for these future high-performance buildings is a *must-do.* Optimized commissioning must be performed for all energy consuming and energy producing systems in the building. Building envelope pressure testing (blower door testing) and thermal scanning is recommended to establish baseline infiltration levels and will help to identify specific areas where improvements are needed.

The level of service and expectations of commissioning should be above and beyond standard commodity commissioning procedures typically seen in the industry. The commissioning effort must include true optimization of system sequences, set-points, and schedules to ensure energy performance goals can be realized. It is critical to plan commissioning (Cx) time in the overall construction schedule and include the appropriate contractor representation to make Cx successful, with the goal of obtaining the required reduction results as soon as possible.

A measurement and verification plan can validate the implemented energy conservation measures obtained the desired energy reductions. In this approach, the contractor obtains and reviews the monthly energy data (electricity and natural gas) provided by the Town for 15 – 18 months post construction as compared to the energy model. As conditions, schedules, and set-points tend to change over time, the energy performance of the building will be affected. The energy data should be verified at least every 6 months.

The plan must review the sub-metered data from the solar PV system. This plan must also include a review of the building's operations. This includes reviewing actual operating hours versus those modeled. After a sufficient time for operations to settle in, the Town must provide 12 months of verified energy data suitable for certification requirements as needed. The overall approach would be in accordance with IMVP (International Measurement and Verification Protocol) Guidelines Option C & D.

PHASE III
INVESTMENT PLAN

PHASE III OBJECTIVES

This project phase uses the analysis from the two phases prior to develop priorities which are placed on a timeline. Recalling that the goal of the Town is to renew aging HVAC systems, achieve full electrification, and improve air quality by 2050, this section details a strategic roadmap.

The analysis between the systems factors in order of magnitude first cost estimates, anticipated annual operating costs, and carbon emissions potential to establish a life cycle cost investment. There are also utility incentives and federal tax dollars that may be available depending on the option chosen. For each site, three alternatives are considered.

The three options are:

1. Variable Refrigerant Flow (VRF) System
2. Ground Source Heat Pump System
3. Business as Usual: Hot Water Heat with full DX Air Conditioning (Fossil Fuel Remains)

The first and second options are those that were proposed as viable all-electric HVAC systems that would provide full heating and air conditioning to all buildings in an energy efficient manner. The design details for these systems are detailed in Appendix A.

The third option represents the business-as-usual case. In this case, the existing natural gas heat remains and electrification is not achieved. The costs associated would be system replacements when systems reach end of life. To make this case comparable to the others, which provide complete heating and cooling, full air conditioning via DX cooling is included. This option demonstrates essentially the minimum cost to the Town to continue to run these six schools over the 30 year period analyzed.

Ultimately, this section provides the Town with the data needed to evaluate the options to meet the goals laid out in the Net Zero Action Plan and Electrification & Air Quality Master Plan. A timeline for renewal is proposed based upon Town priorities which, along with initial costs required to install either system, gives the Town a tool for mapping out the future projects and financial investment required to reach its goals.

Life Cycle Cost Analysis Methodology

LCCA inputs included first cost data, utility costs, inflation rate, and estimated maintenance. The first cost data come from the cost estimations of the VRF and Ground Source Heat Pump Systems described in further detail in Appendix D. Utility data costs were calculated using the 2022 blended utility rates provided by the Town, $0.25/kwh and $1.15/therm, for electricity and natural gas, respectively. An inflation rate of 6% was applied to natural gas and 5% was applied to electricity. Maintenance was estimated on a square foot basis per system and subject to market escalation, which was estimated at 2% annually.

Replacement costs at year 20 are a percentage of the first cost, escalated out to 20 years. The percentage applied depends on the average lifespan of system components, and the total estimated amount of equipment that would be replaced at that time.

Life Cycle Cost Analysis Trends

Studying the results, a few trends emerge:

- In every case, when looking at first cost of the HVAC system alone, the ground source heat pump option is more expensive than the variable refrigerant flow option. The existing heat and DX cooling option first cost falls between that of VRF and geothermal.
- When looking at life cycle costs, with no incentives, the ground source heat pump system becomes less expensive than the VRF system in all but one case (Peirce) where the systems cost the same amount.
- Taking market and legislative conditions into account, the Inflation Reduction Act and Mass Save expected incentives were applied. Based on the incentives available, the ground source heat pump system becomes significantly less expensive, whereas the VRF system qualifies for fewer incentives, so costs decrease only slightly. Notably, with incentives, the VRF system cost is comparable to the cost of the existing heat and DX cooling option, which remains more expensive for all schools than the geothermal option. The savings in today's dollars from incentives when totaled across the six schools are $1.3 million for VRF and $27.5 million for the ground source heat pumps.

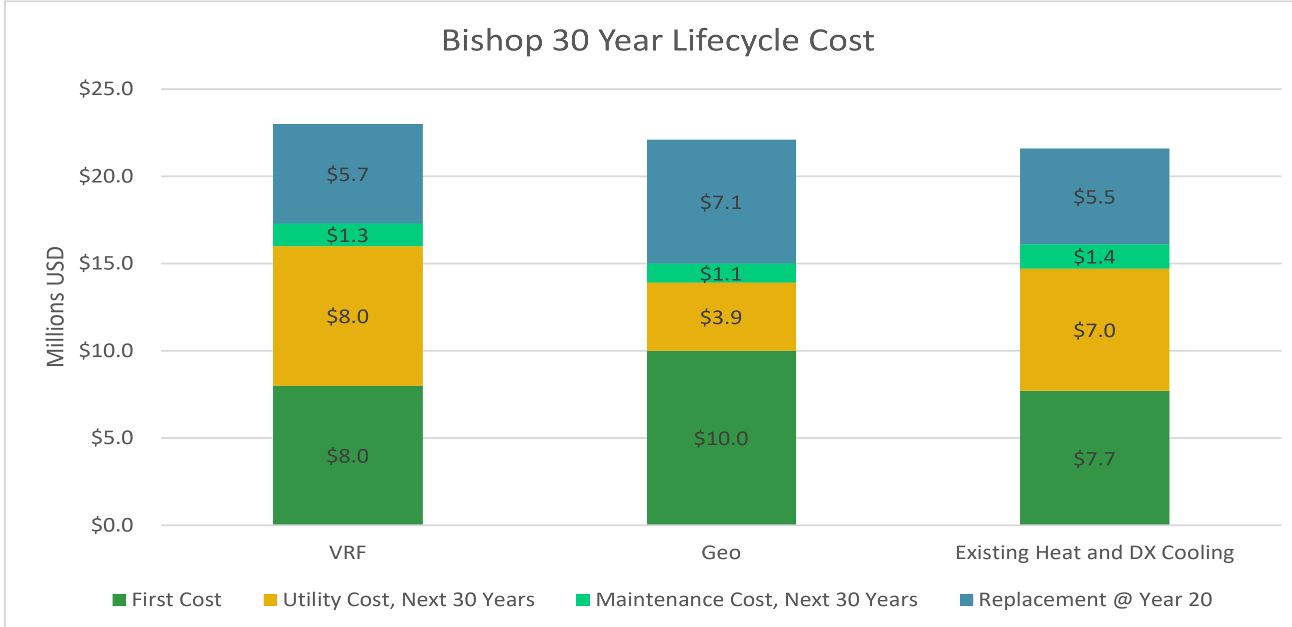
It is critical that the Town consider life cycle costs when evaluating viable electrification options. Selecting a less efficient system or looking strictly at first cost alone could lead to a choice that spends more money than is necessary. Looking at the group of six schools, in today's dollars and with incentives, the difference in life cycle costs between the VRF and ground source heat pumps options is $34.3 million. This is the equivalent of 635 teachers' annual salaries, using the average Massachusetts teacher's salary of $54,000.

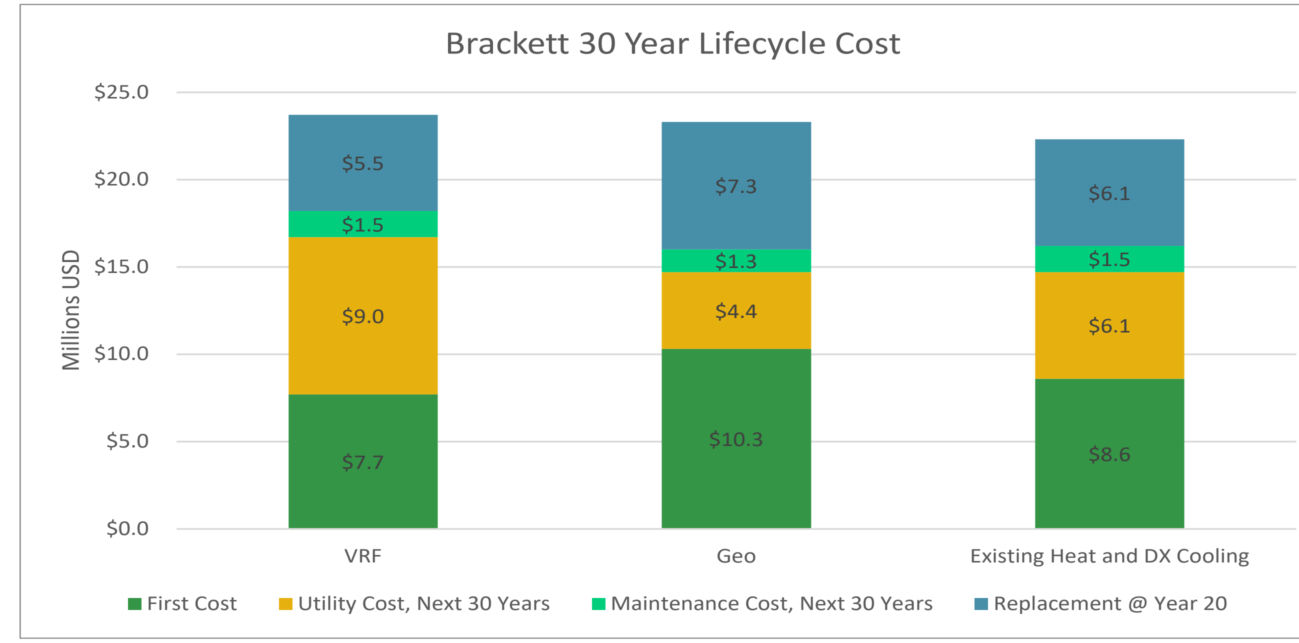
Life Cycle Cost Analysis Data

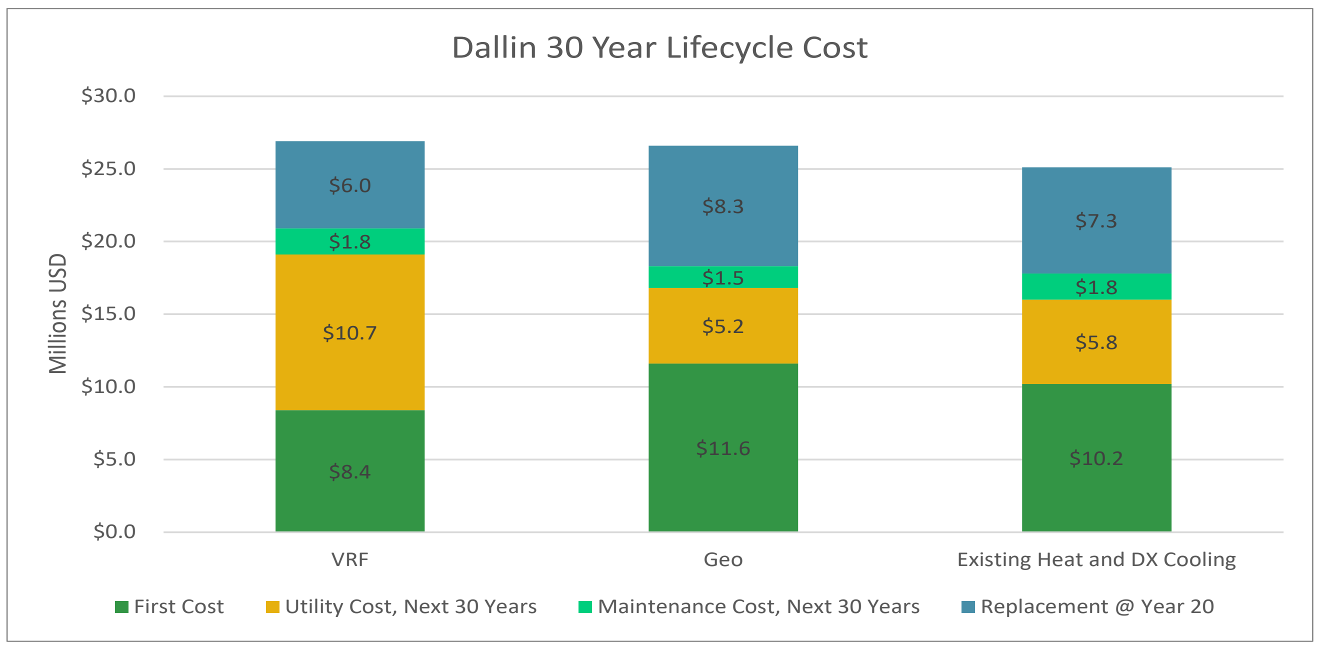
The charts and graphs on the following page offer the Town the ability to consider the options through several lenses. In every instance, the "In-Kind" case is shown as a point of comparison. It is essentially a do-nothing, business as usual case where on-site fossil fuels remain. It will not achieve the Town's stated goals of electrification and improved air quality.

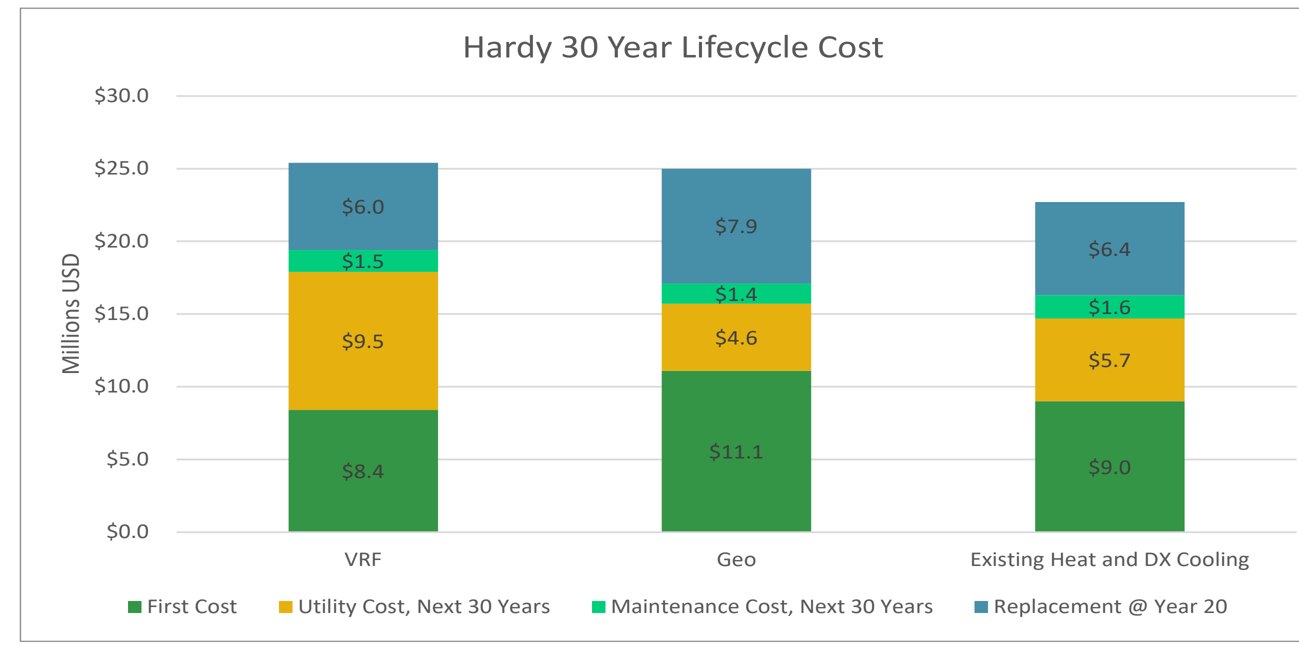
The bar charts build a picture of costs, starting with initial investments that would occur in year one of any given project, followed by a series of 30-year life cycle costs. Complete life cycle costs for are shown first, followed by the same case with IRA incentives applied, and ending with the addition of Mass Save incentives.

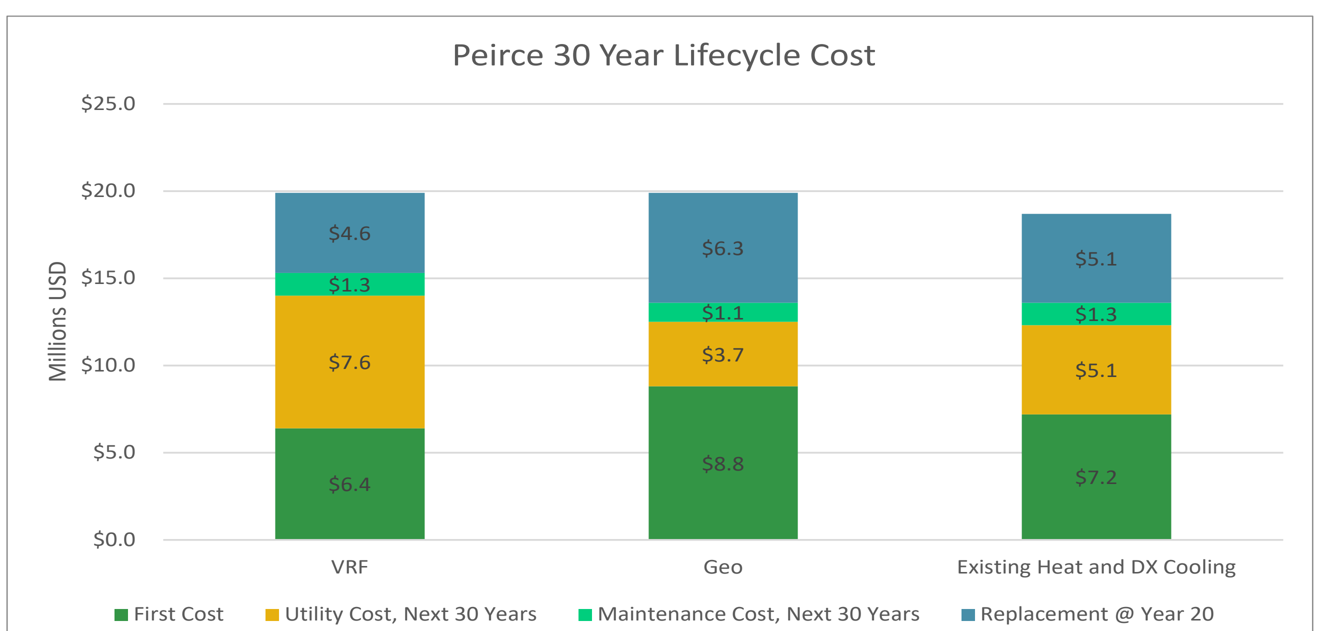
30 YEAR LIFE CYCLE COST

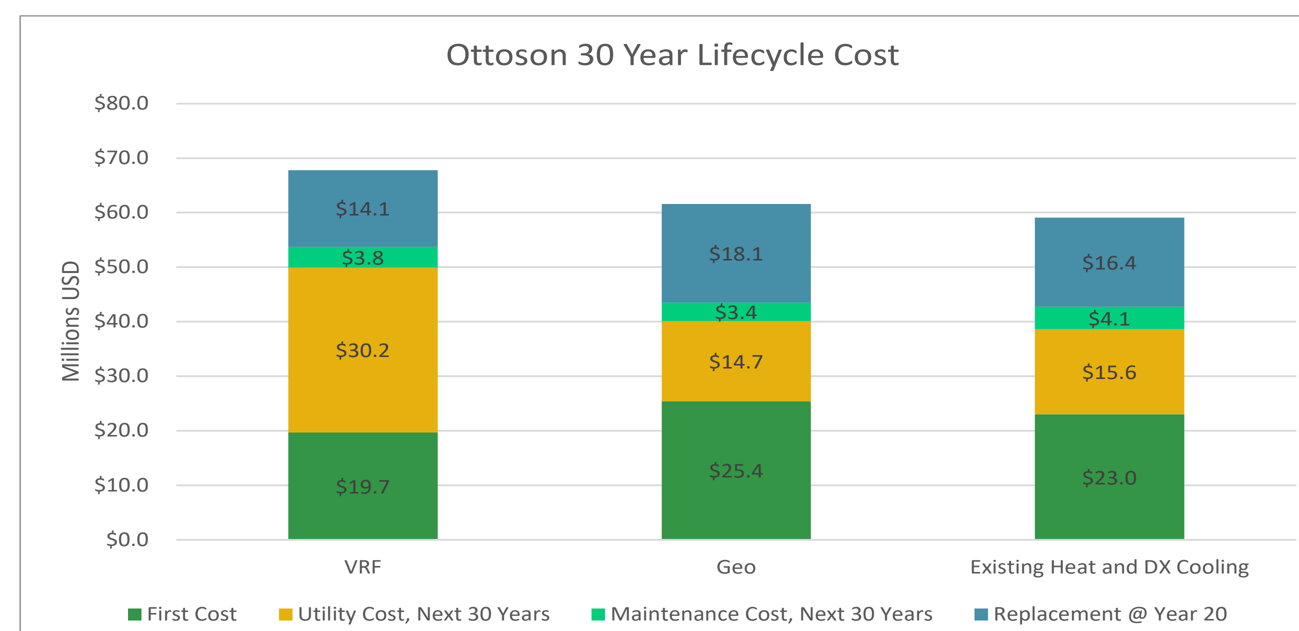




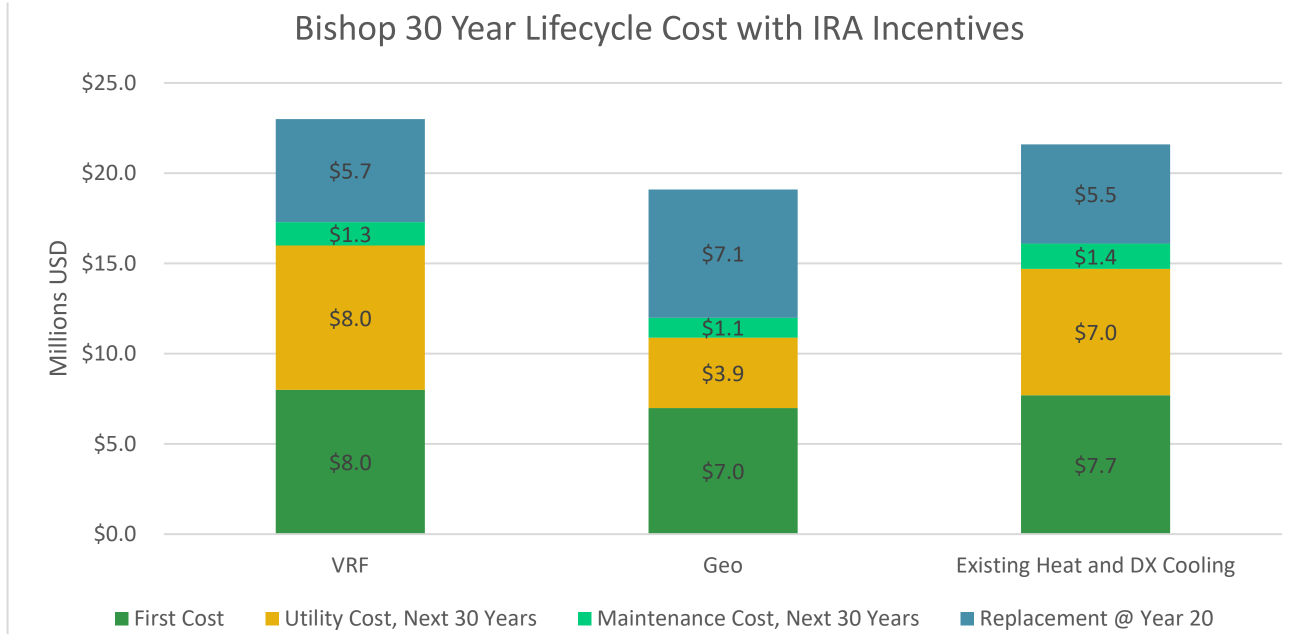


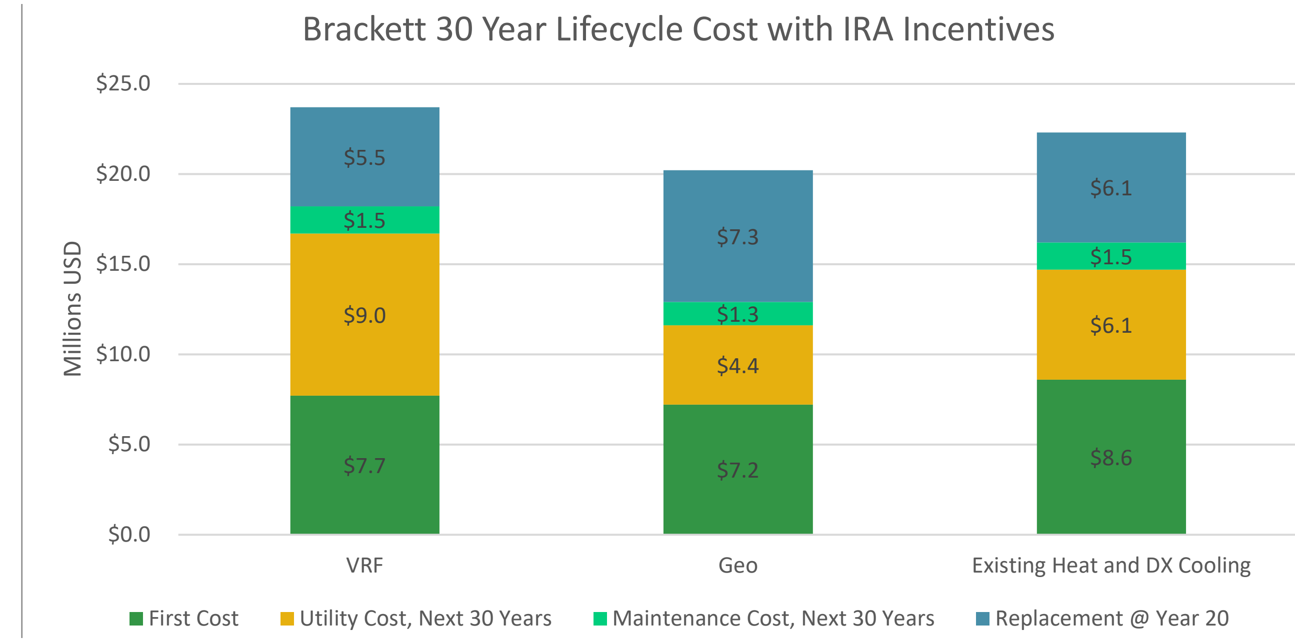


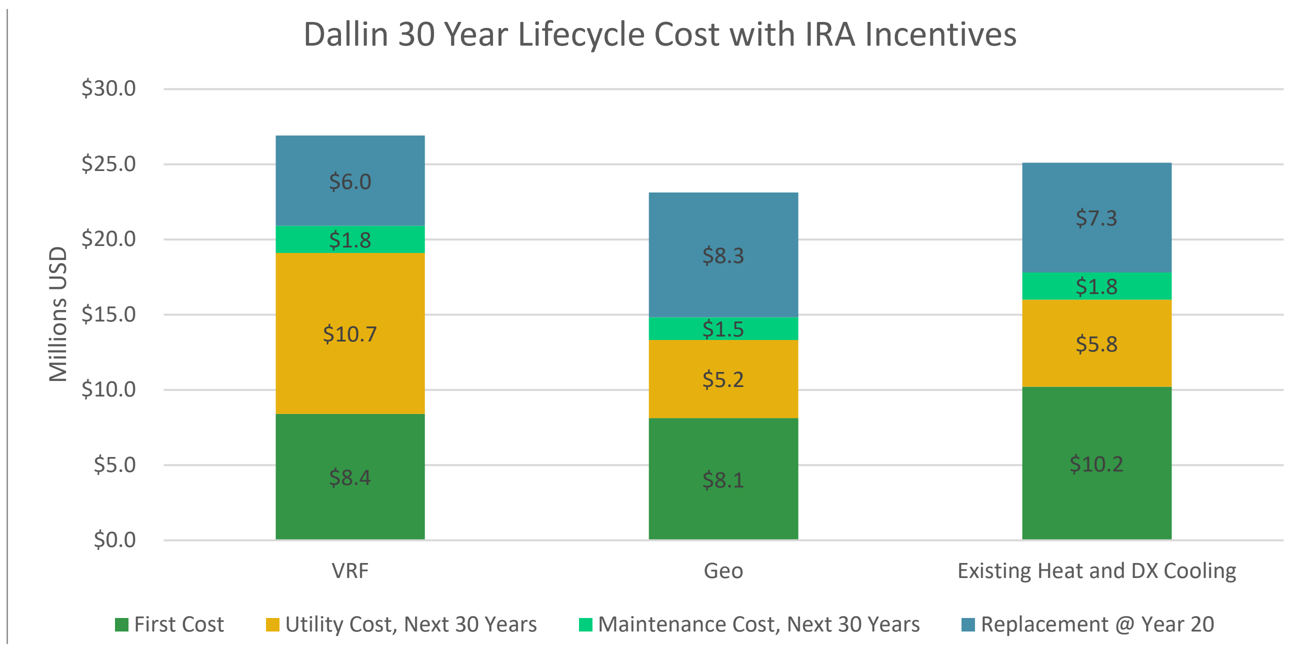


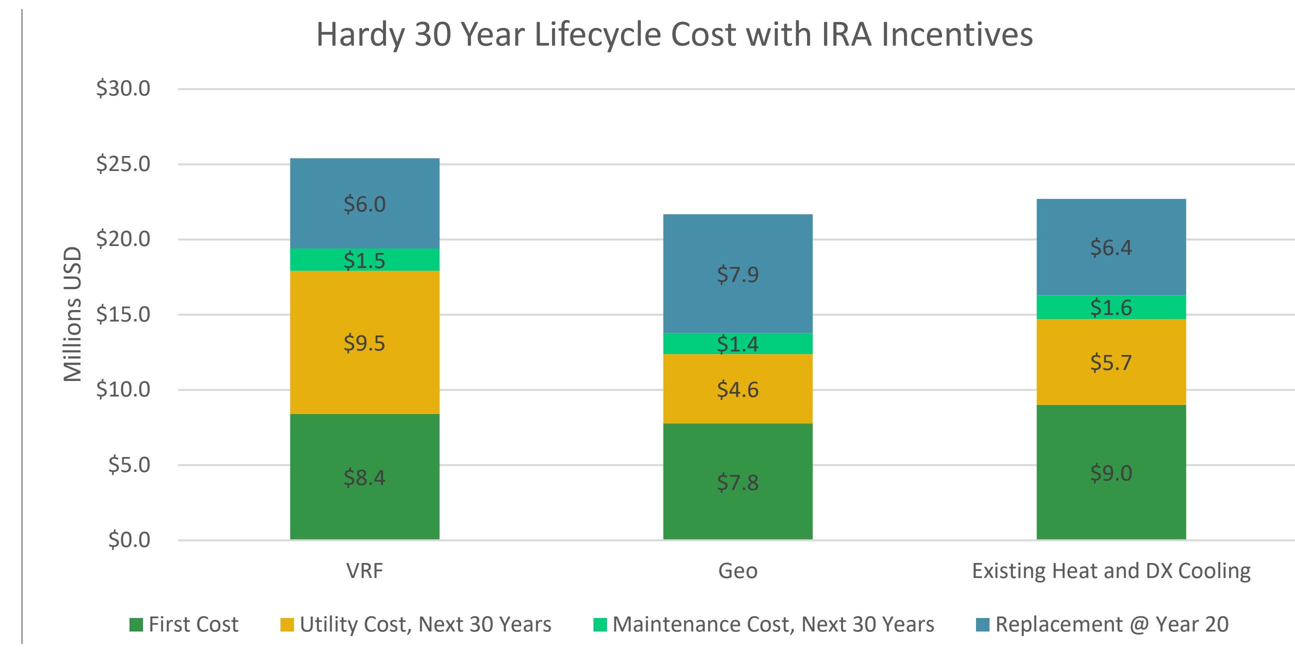


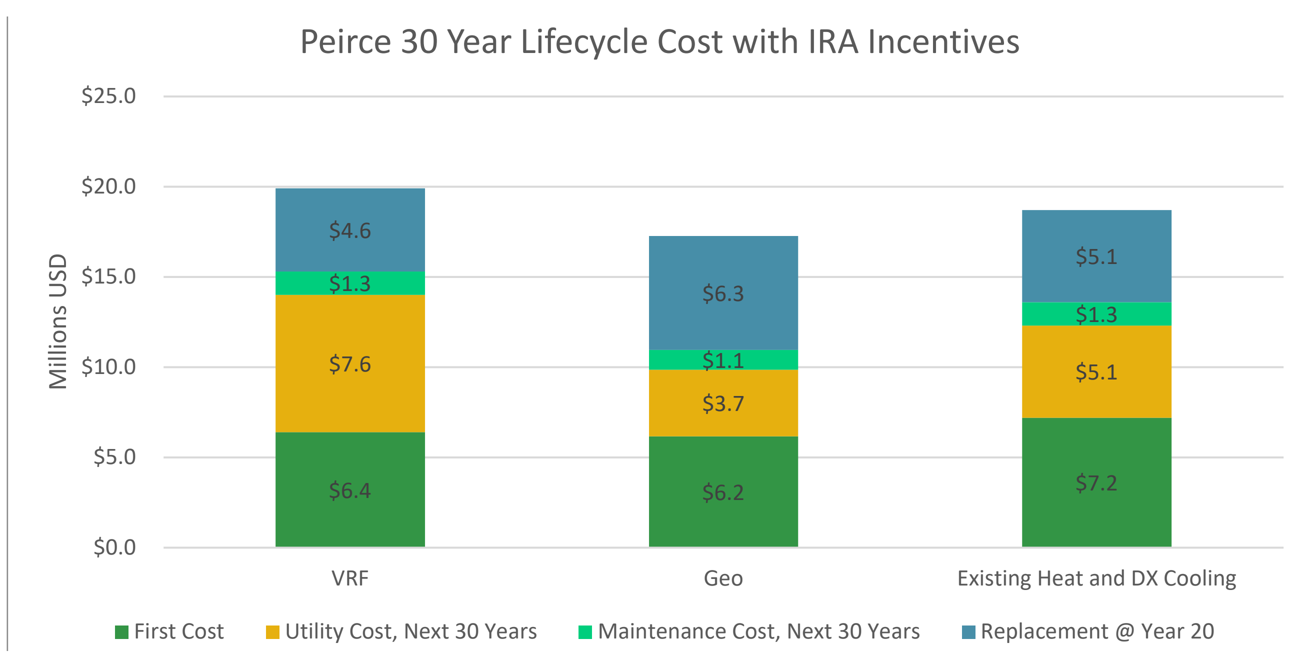
30-YEAR LIFE CYCLE COST WITH IRA INCENTIVES

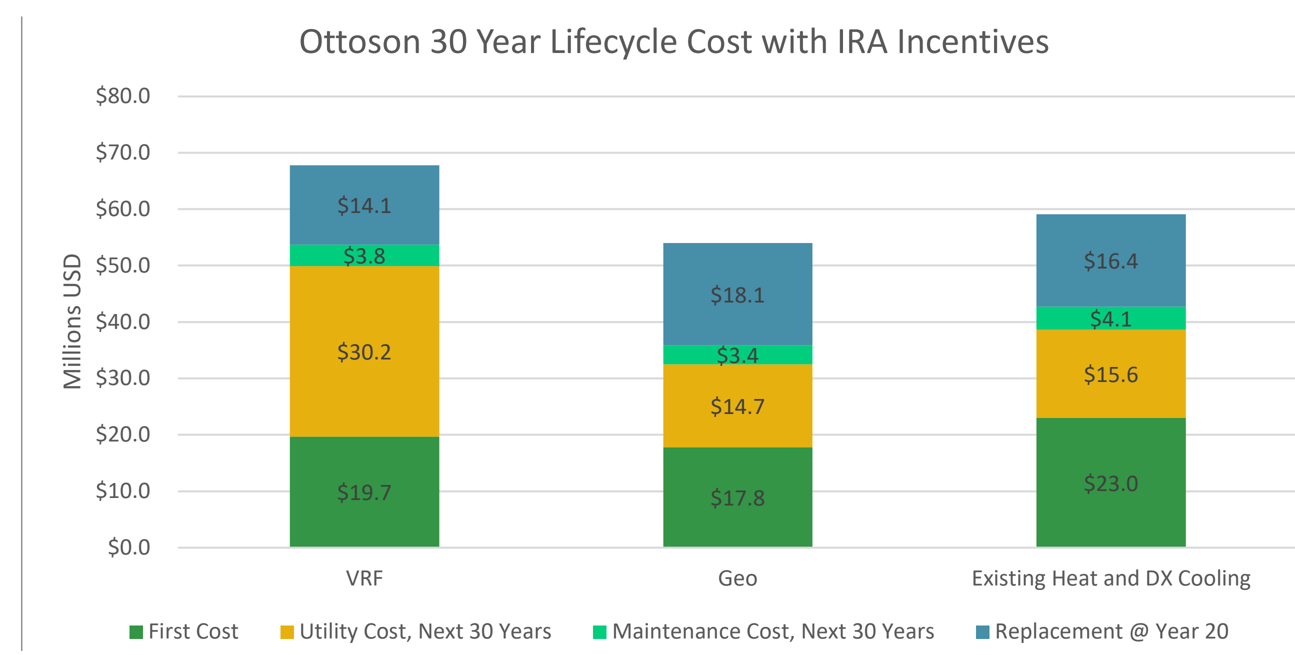




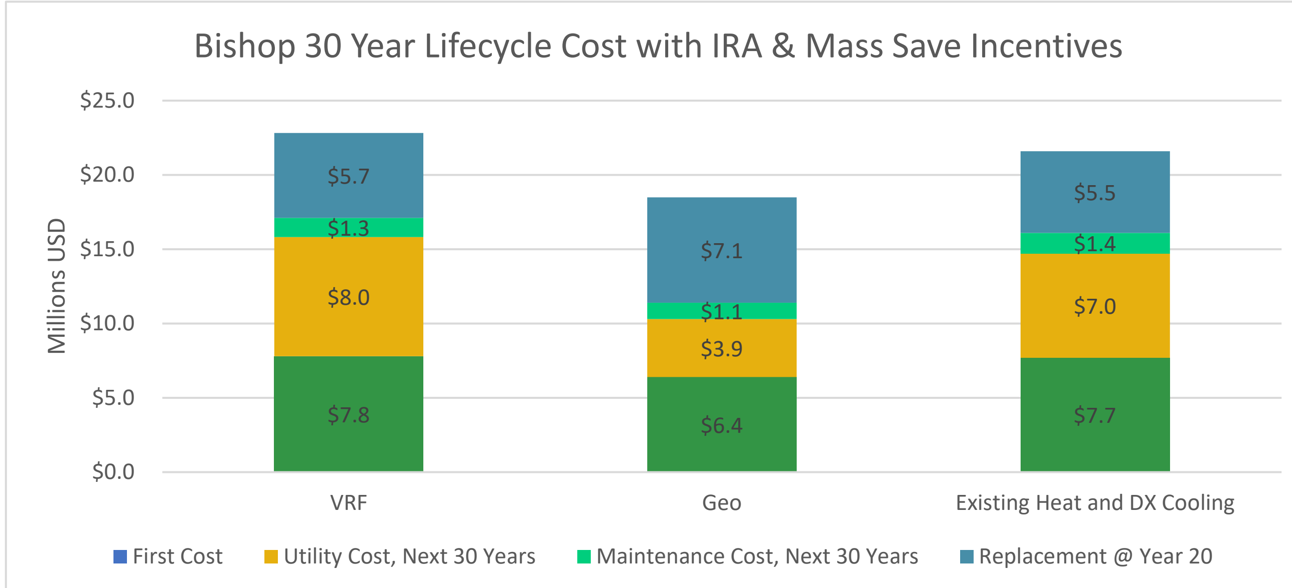


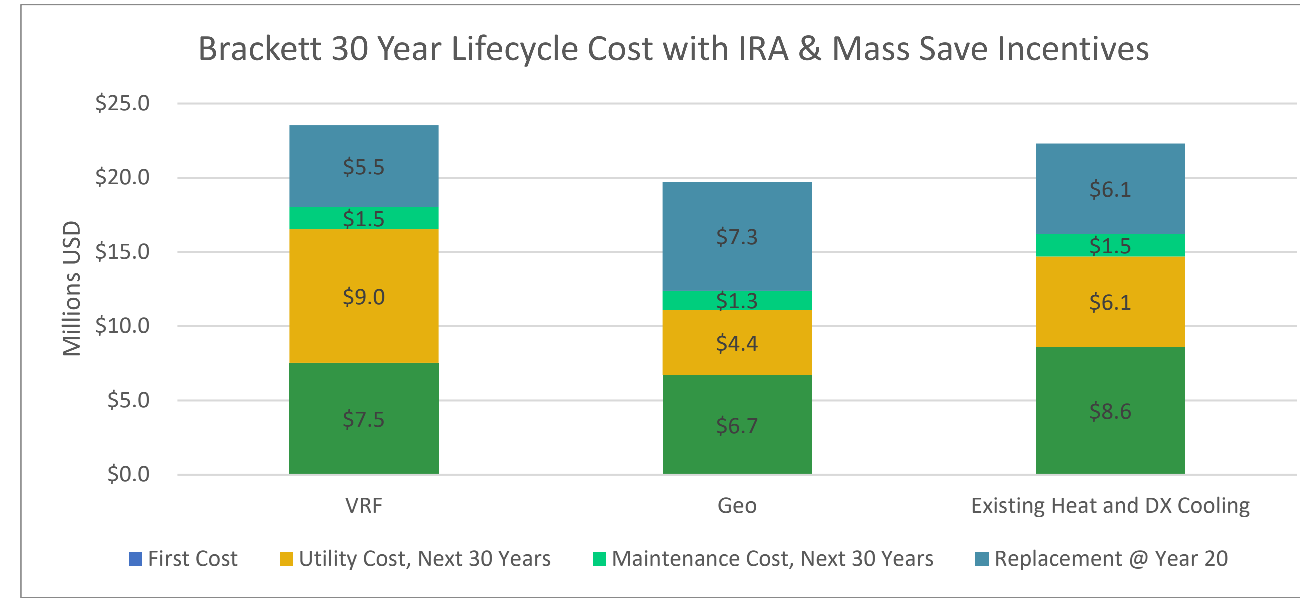


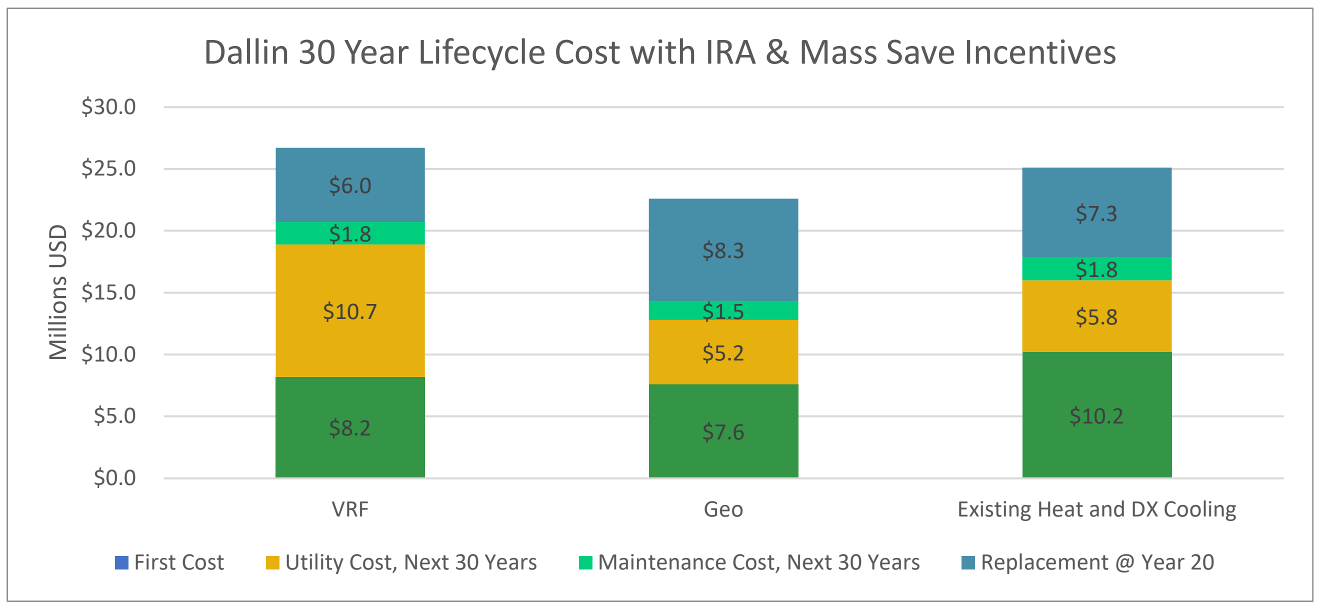


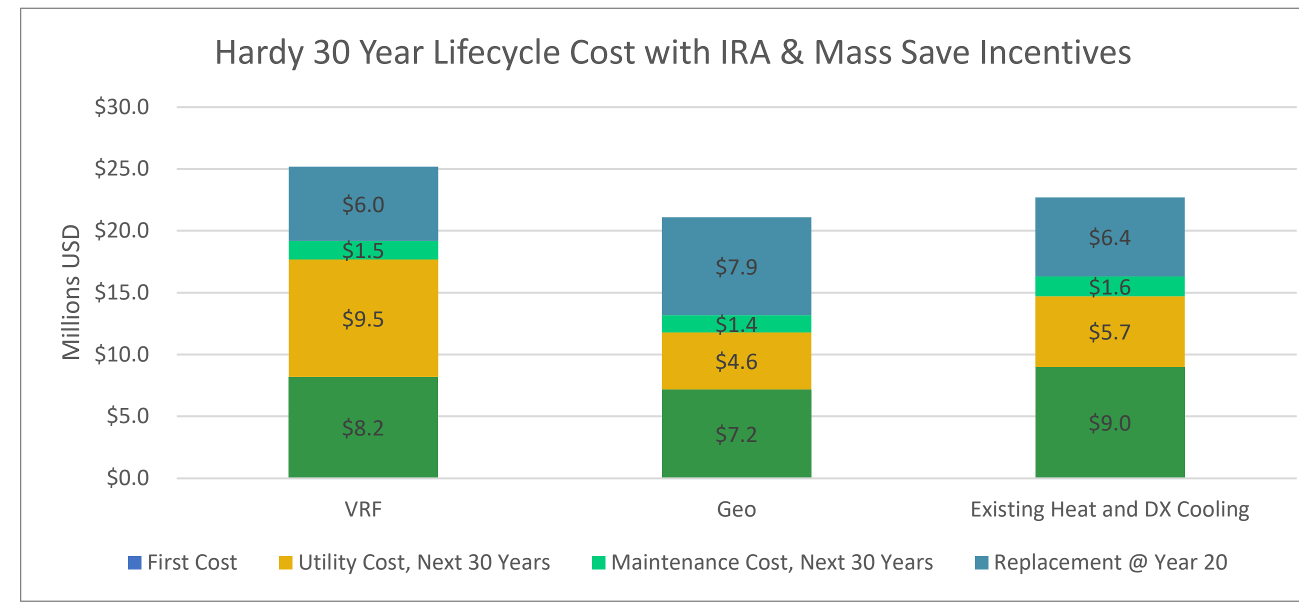


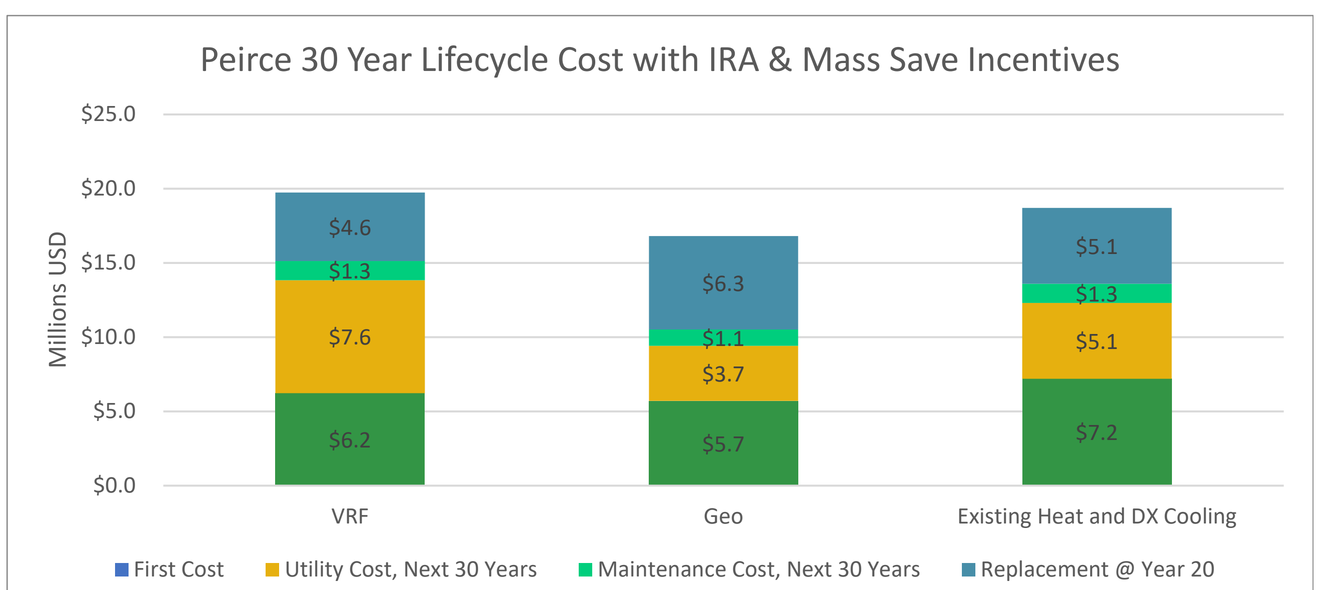
30-YEAR LIFE CYCLE COST WITH IRA & MASS SAVE

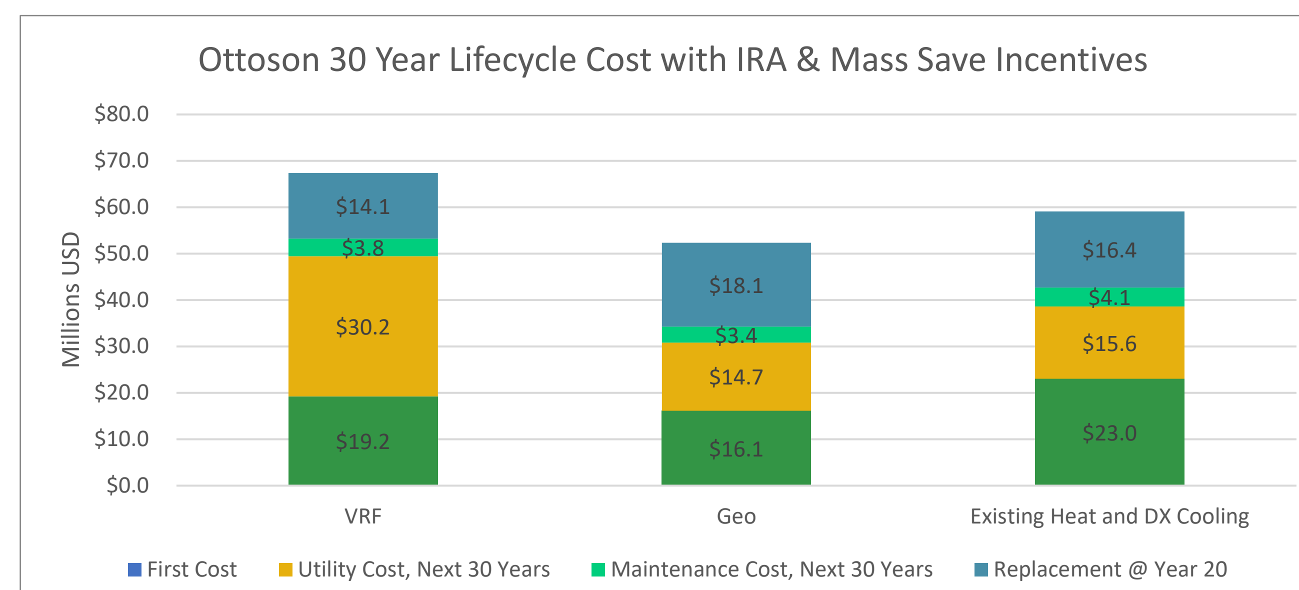












Incentives

Utility Incentives

Massachusetts offers a robust utility rebate and incentive program called Mass Save that is administered through the major utility providers (National Grid, Eversource, etc.). There are several paths available within this program. The local utility should be included when embarking on any renovation project to determine if any energy efficiency measures can be utilized to receive rebates or incentives. The program details are found here: https://www.masssave.com/en/saving/business-rebates/new-buildings-and-major-renovations/whole-building-energy-use-intensity-reduction

PATH 2: WHOLE BUILDING EUI REDUCTION APPROACH	
Customer Incentives	
Incentive rate range (based on EUI % reduction)	$0.35/sf - $1.25/sf
Space Heating Heat Pump Adder	
• Air Source Heat Pumps:	$800/ton
• Variable Refrigerant Flow (VRF):	$1,200/ton
• Ground Source Heat Pumps:	$4,500/ton
Technical Assistance	up to 75% cost share (capped at $20,000 per Sponsor)
Verification Incentive	50% of fee up to $10,000

Percent EUI Reduction	
25.0% and above	$1.25/sf
20.0% - 24.9%	$0.75/sf
15.0% - 19.9%	$0.50/sf
10.0% - 14.9%	$0.35/sf

Incentives are summarized in the figures above. With 441,000 SF across the six schools and an expected reduction of at least 50-70%, there is potential to receive an incentive of ≈$550,000 in total ($1.25/SF). If geothermal heat pumps are selected, the full $1.25/SF is expected. If VRF is selected, the EUI reduction would be half as much as in the geothermal case, so the estimated incentive is lower. The calculations in the chart below estimated a $1/SF for VRF. The following incentives could be anticipated for each of the schools.

Additionally, there are the Space Heating Heat Pump adders. Both electric HVAC systems considered are eligible at $1,200/ton for VRF and $4,500/ton for ground source heat pump. The estimated tonnage from this study was used to calculate the adder incentives.

With both incentive types, the expected Mass Save incentives are estimated to total:

	Variable Refrigerant Flow	Ground Source Heat Pump
Bishop Elementary School	$ 169,000	$ 599,000
Brackett Elementary School	$ 151,000	$ 548,000
Dallin Elementary School	$ 189,000	$ 529,000
Hardy Elementary School	$ 195,000	$ 586,000
Peirce Elementary School	$ 159,000	$ 459,000
Ottoson Middle School	$ 438,000	$ 1,655,000

All numbers are estimates based on the schematic designs and would need to be reassessed after Construction Drawings are completed. There are also opportunities to engage the students, faculty, and staff in the energy conversion efforts in these schools through the Mass Save program. More on those programs here: https://www.masssave.com/en/learn/activities-and-school-resources

Inflation Reduction Act

Within the period this study was completed, the United States House and Senate passed the Inflation Reduction Act. The $740 billion package includes around $370 billion for climate change and energy efforts. These provisions could result in additional funding for the Town's electrification goals.

Public K-12 School Systems, Universities, and Municipal City/Counties are tax exempt and therefore qualify for the direct-payment option of the investment tax credit (ITC) including ground source heat pumps and solar. These incentives should apply to any projects placed into service after December 31st, 2022, which would include all six projects. For the Town of Arlington, the expected impact would include:

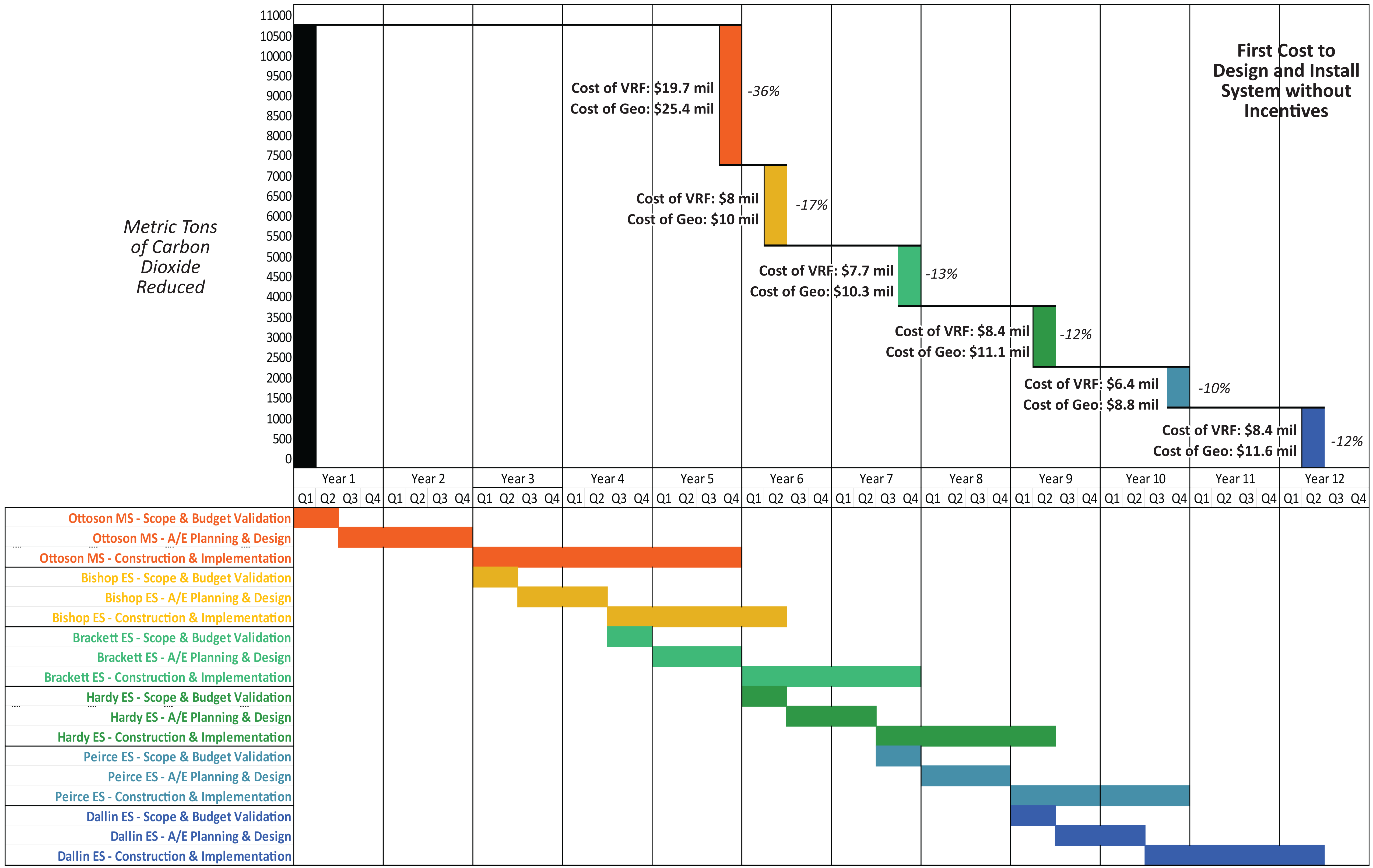
- ITC of 30% for projects that commence construction on or before 2032 and then phases down to 26% for projects that begin construction in 2033 and 22% for projects that commence construction in 2034. The ITC will apply as long as the property has begun construction before January 1, 2035.
    - If the phasing in the following section is adopted, then all six school projects would occur before that 2035 cut off.
- The "Direct-Payment" reimbursement similarly applies to the Solar Array, essentially providing a 30% reimbursement for installing and owning photovoltaic arrays.

The chart below reflects the expected total incentives per system:

	Variable Refrigerant Flow	Ground Source Heat Pump
Bishop Elementary School	$ 0	$ 3.0 million
Brackett Elementary School	$ 0	$ 3.1 million
Dallin Elementary School	$ 0	$ 3.5 million
Hardy Elementary School	$ 0	$ 3.3 million
Peirce Elementary School	$ 0	$ 2.6 million
Ottoson Middle School	$ 0	$ 7.6 million

Analysis with these incentives is included below. Note that these numbers are estimates and would require review by the Town's legal, accounting, and tax advisors to confirm.

STRATEGIC ROADMAP



The main findings of the Master Plan conducted are summarized in the Strategic Roadmap to Electrification. The analysis presented optimized the ranking and sequencing of projects based on order of magnitude of cost, emissions reduction potential, and need for infrastructure renewal. These recommendations are detailed in the Phase III section of this report. While the established goal of electrification by 2050 may seem far in the future, when considering the project scope to retrofit six schools, factoring in the design and construction period, as well as the planning for funding outlays of this magnitude in advance, the Town ishould initiate this process early. The chart above is the culmination of all three phases. It shows the recommended project phasing, the impact project completion would have on site emissions in the Town of Arlington, and the first cost for each viable, fully electrified option.

FUNDING FLOWS

	Variable Refrigerant Flow		Ground Source Heat Pump	
	Spend	**Rebate/Incentive**	**Spend**	**Rebate/Incentive**
Year 1				
Ottoson MS	$ (19,700,000.00)		$ (25,400,000.00)	
Year 2				
Year 3				
Bishop ES	$ (8,000,000.00)		$ (10,000,000.00)	
Year 4				
Brackett ES	$ (7,700,000.00)		$ (10,300,000.00)	
Year 5				
Year 6				
Hardy ES	$ (8,400,000.00)		$ (11,100,000.00)	
Ottoson MS Mass Save Incentive		$ 438,000.00		$ 1,655,000.00
Ottoson MS IRA Incentive		$ -		$ 7,600,000.00
Year 7				
Peirce ES	$ (6,400,000.00)		$ (8,800,000.00)	
Bishop ES Mass Save Incentive		$ 169,000.00		$ 599,000.00
Bishop ES IRA Incentive		$ -		$ 3,000,000.00
Year 8				
Brackett ES Mass Save Incentive		$ 151,000.00		$ 548,000.00
Brackett ES IRA Incentive		$ -		$ 3,100,000.00
Year 9				
Dallin ES	$ (8,400,000.00)		$ (11,600,000.00)	
Year 10				
Hardy ES Mass Save Incentive		$ 195,000.00		$ 586,000.00
Hardy ES IRA Incentive		$ -		$ 3,300,000.00
Year 11				
Peirce ES Mass Save Incentive		$ 159,000.00		$ 459,000.00
Peirce ES IRA Incentive		$ -		$ 2,600,000.00
Year 12				
Dallin ES Mass Save Incentive		$ 189,000.00		$ 529,000.00
Dallin ES IRA Incentive		$ -		$ 3,500,000.00
Totals	$ (58,600,000)	$ 1,301,000	$ (77,200,000)	$ 27,476,000
Net Spend	**$**	**(57,299,000)**	**$**	**(49,724,000)**

The table above demonstrates the first cost allocations and expected incentives for each system. First cost represents the cost for either system in year one of a project. For any incentives, disbursment is typically allocated one year after the project is completed. The delay reflects the estimated time required to conduct a cost segregation study.

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